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THE LLANDULAS VIADUCT.

No more striking example of rapid bridge construction exists than that afforded by the restoration of the Llandulas Viaduct on the main line of the London and North-Western Railway between Chester and Holyhead, and not far from Rhyl. The disastrous floods which occurred during August last destroyed the old viaduct which carried the railway over the river Dulas, severing one of the main arteries of the London and North-Western Railway system, and interrupting one of its most important branches of traffic. The old viaduct was a heavy masonry structure, consisting of seven arches about 28 ft. span, and of six piers, the approaches on either side being formed of embankments. The accident occurred on Sunday, the 17th of August last, at four o'clock in the afternoon, and only a quarter of an hour after a train had passed over the bridge; the flood water, which converted the Dulas for a time into an overwhelming torrent, swept away the viaduct, throwing piers and arches into one mass of ruin. It was not until the early morning of Tuesday, the 19th of August, that it was possible

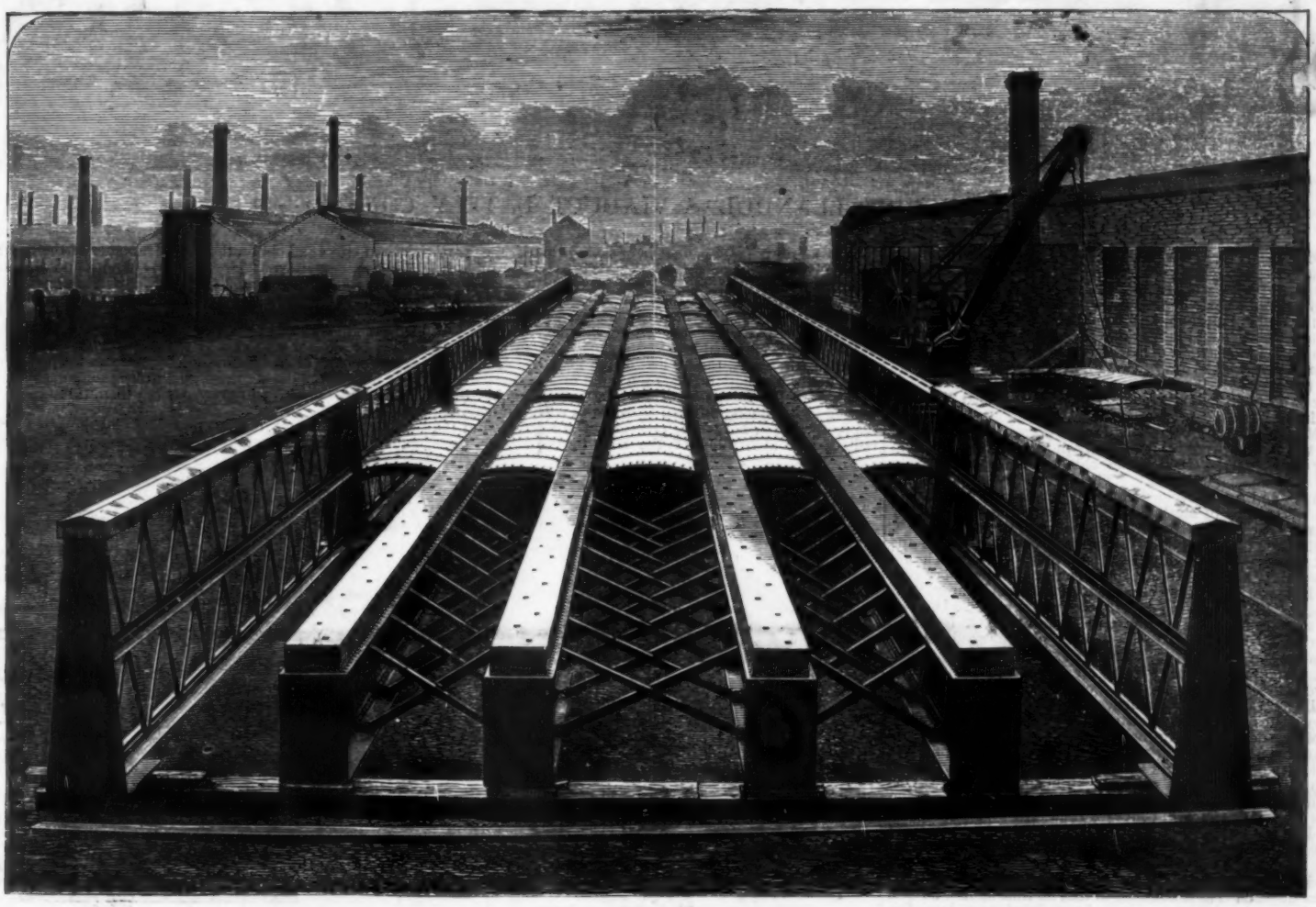


FIG. 1.—SECTION OF SUPERSTRUCTURE.—LLANDULAS VIADUCT.

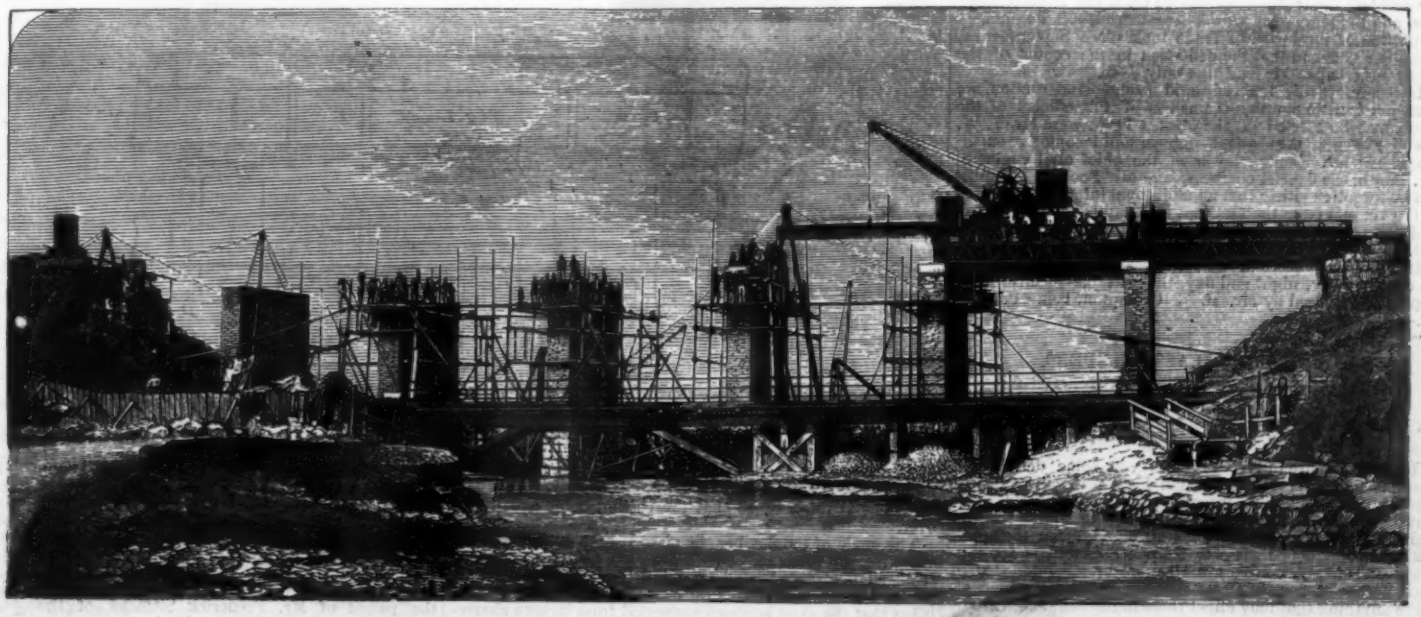


FIG. 2.—CONSTRUCTION OF THE LLANDULAS VIADUCT.

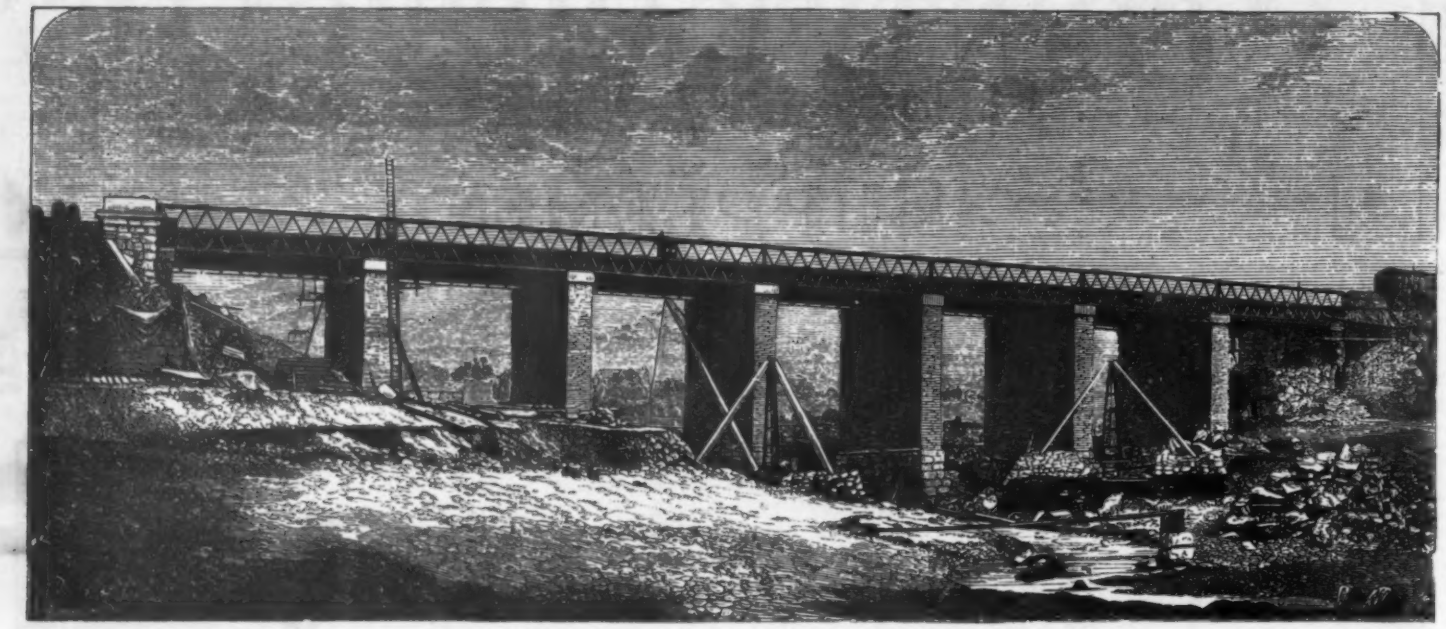


FIG. 3.—THE NEW LLANDULAS VIADUCT LATELY CONSTRUCTED.

to commence the temporary works which had to be constructed pend'ng the permanent restoration of the viaduct; these temporary works consisted of a timber trestle bridge and a diversion of the line on each side. The interruption to the traffic, therefore, lasted only a week, during which time passengers and luggage were transferred by road from the station at Abergele to that of Llandulas; these temporary works were carried out by Mr. Footner, one of the officers of the company, in three hours less than seven days, including two days of enforced inactivity while the flood was subsiding.

Meanwhile the preparations for the permanent restoration of the viaduct were being actively pushed forward, and at the same time the *débris* of the old bridge was removed, a work of no small difficulty. The distance to be spanned is 224 ft., and it was decided that the superstructure should consist entirely of steel, the girders resting upon masonry piers. The total distance was divided into seven openings, each of 32 ft. in length, and the height of the tallest of the six piers is 50 ft.; the lower part of these piers, which are about 4 ft. in thickness, are of masonry, and the upper part of brickwork, and they are connected together near their foundations by masonry inverts, which are protected up and down stream by aprons; the whole of the work is set in Portland cement. The illustrations give a good idea of this portion of the work. As soon as the general plan of the bridge was decided upon, Mr. F. W. Webb, the chief mechanical engineer for the London and North-Western Railway Company, commenced the manufacture of the steel plates for the superstructure. There were in all 42 girders, each 32 ft. long, besides transverse girders, flooring plates, etc.; but the work was simplified by adopting the bold device of rolling all the plates and angle irons for the top and bottom girders of each span in single lengths. One figure of our engravings showing one of the spans erected in the yard at Crewe, will convey a good idea of the character and design of the bridge. In the incredibly short space of seven days the whole of the material was turned out ready for erection, the steel having been manufactured, rolled, and worked up at Crewe. As rapidly as possible the material was dispatched to Llandulas, so that no time should be lost in the erection, which was indeed completed seven days after the last of the steelwork had been delivered at the site. One of our illustrations shows the manner adopted for erection, and from this it will be seen that the work was carried forward from one end of the viaduct, each span as it was completed serving as a platform for the erection of the next; some slight delay was incurred during construction, from the fact of the piers not being completed as soon as the superstructure. In somewhat less than a month from the time of the accident the traffic was diverted on to the re-established line, and the temporary works became useless. The official inspection of the Board of Trade took place September 22, when it was found that the deflection in the center of the spans under a passing load was only $\frac{1}{4}$ in.

In recording this feat of rapid bridge construction, we must not omit to mention the names of the officers of the company who carried out the work. These were Mr. F. W. Webb, the chief mechanical engineer and locomotive superintendent; Mr. Frank Stevenson, the chief civil engineer; Mr. Smith, the district engineer; and Mr. Footner. It must not be forgotten either that an additional interest is attached to the viaduct from the fact that it is built wholly of steel, and that there are no cover or joint plates used in it throughout.

It is almost unnecessary to state that the work was carried on continuously, night and day, the portable electric light apparatus, devised by Mr. R. E. Crompton, being employed.—*Engineering.*

TOUGHENED GLASS SLEEPERS.

By C. WOOD, M. INST. C. E.*

ON THE APPLICATION OF TOUGHENED GLASS TO PERMANENT WAYS.

I HAVE pleasure in laying before you some details and specimens of an invention which I am sure will be looked upon with considerable interest, not only from its great novelty, but because it may have some effect upon the iron industries of this and other countries. I mean the application of toughened glass to sleepers and chairs for railways or tramways. We are all more or less interested in the success of iron or steel. We are also equally interested in anything that may affect those industries; and without expressing any opinion upon the toughened glass as applied to railway purposes, I cannot help saying that if the particulars given to me are correct, it must have a wonderful future before it.

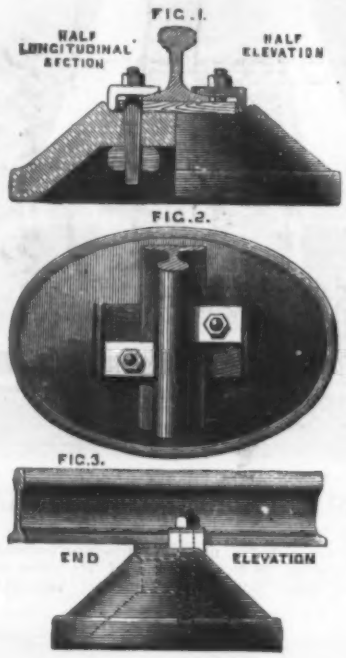
Mr. Hamilton Lindsay Bucknall, Associate Inst. C. E., the inventor of this new application, has kindly given me the following particulars concerning his glass sleepers.

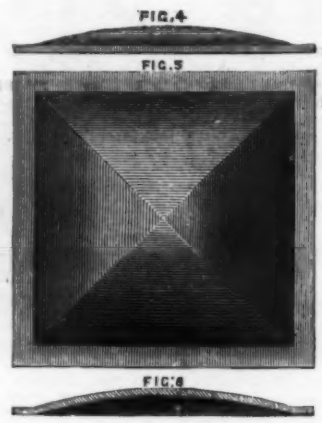
The glass is moulded into various forms to suit the different requirements, the cooling of the glass being so regulated that the radiation from each point of the surface corresponds to the thickness of the glass, thus enabling the casting to be equally affected throughout when undergoing the tempering or hardening process. The regulation of the radiation or absorption of the heat in the thicker parts of the casting is done by having iron moulds hollow, and by circulating cold water or cool air at those points where the glass is thickest, so that the casting cools equally all over.

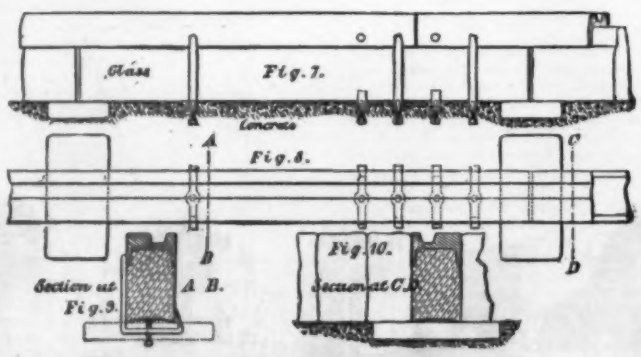
The mode of toughening the glass is both curious and instructive, affording as it does a complete contrast to that of steel. The glass is heated to a high temperature and then plunged into a bath of cool oil or other liquid, the result being that the glass becomes converted from its own characteristic brittleness to the remarkable tough fibrous material known as toughened or tempered glass; but to produce the desired effect and obtain the full advantages of the toughening process upon articles of great strength and thickness, Mr. F. Siemens has found that the hardening or tempering can be effected in the moulds themselves: First, by carefully protecting the glass from coming in direct contact with the metal mould, to prevent the chilling of the surface of the glass; and secondly, by the use of the hollow moulds before spoken of, for maintaining a uniform temperature all over the casting during the hardening. The temper is modified in these thick castings by passing them through an annealing oven.

The moulds are chiefly protected by layers of wire gauze, perforated metal, or plaster of Paris, varying in layers or thickness according to the rapidity and energy required in tempering with the nature and composition of the glass—this energy being increased at the thick parts of the casting before alluded to by the circulation of cool water or air through the cast iron hollow mould. So far as experience has shown, all kinds of glass are equally affected by the process.

The toughening process as well as the hollow moulds are the patent of Mr. Frederick Siemens, of Dresden, and recently brought by that gentleman to great perfection by the simple and inexpensive means above alluded to. The







TOUGHENED GLASS SLEEPERS.

* Paper read before the Iron and Steel Institute at Liverpool.

first cost of this specially prepared material will not exceed that of cast iron; but the specific gravity of glass is only one-third that of iron, and its strength for all practical purposes is as great. A large output is anticipated, and in this way it is calculated that the first cost of glass will be considerably less than that of iron; and by a similar calculation can be shown to be cheaper than wood. It is asserted that these glass sleepers will, as far as one is able to judge, last a very long time, being neither subject to corrosion nor decay. Under these circumstances it will be unnecessary here to enter into any calculations to prove the enormous saving that will be effected in the maintenance and renewal of permanent ways. Such a fragile material as glass has hitherto been looked upon as useless for purposes where great strength is required; but impossible as it may sound, the toughened glass is almost as strong as iron, while it possesses greater durability. Its qualities certainly deserve a fair trial and investigation, and the time may come when we shall see not only glass sleepers, but glass tools and implements, eaves troughings, or spouting, for furniture, and many other things.

Some of these glass sleepers are laid down upon the North Metropolitan Tramway (Figs. 7 to 10 p. 3288). They are laid longitudinally in 3 ft. lengths, 6 in. by 4 in., and are specially formed on the upper surface to allow of the rail exactly fitting. The average transverse resistance of the sleepers, tested at Mr. Kirkaldy's works in Southwark, supported at 30 in., was found to be about 5 tons.

The following are results of tests carried out at the works of Mr. William Henderson, of Irvine, N. B.

A falling weight of 9 cwt. dropped from a crane upon a glass plate, 9 in. by 9 in. by 1¼ in., laid upon gravel ballast 9 in. deep, with a wood cushion ⅛ in. in thickness between the glass and the rail—

Fall,	3 ft.	0 in.	without effect.
"	5 "	6 "	"
"	7 "	0 "	"
"	12 "	6 "	"
"	15 "	0 "	"
"	17 "	6 "	"
"	20 "	0 "	"

At this point the rail broke, and as the crane could not elevate the weight to a greater height, and a heavier weight was not available, a smaller section of rail was substituted, when the glass succumbed to a second application of the 9 cwt. dropped from a height of 20 ft. A series of similar experiments were made upon this occasion with more or less the same results. A ½ in. cast iron plate, 9 in. by 9 in. by ½ in., tested in the same manner and under similar circumstances, broke with a drop of 10 ft. Several samples and specimens are upon the table. Amongst which is a bowl sleeper (shown in Figs. 1 to 3), also a buckled plate for floors (shown in Figs. 4 to 6).

Mr. Bucknall proposes to make these sleepers out of blast furnace slag under Mr. Bashley-Brittain's process, combined with the toughening process of Mr. Siemens. After describing to the writer the difficulties he has had in getting his experiments carried out in England, the inventor mentions among other things that the glassmakers to whom he applied would not undertake any experiments unless all expenses were paid, and that these manufacturers would not make the moulds or presses for the process, but recommended other firms. On application to the pressmakers, however, he got a quotation asking between 70*l.* to 80*l.*, and it was stated that it would take three months to invent, and that he must be responsible for any extra charges made. Under these circumstances he says, "I gave up in despair, but having casually heard of the Siemens process, I got an introduction and was put in communication with Dresden, and within a week found myself at the glass works of Mr. F. Siemens in that city. In another week a wooden model, which cost 2*s.* 6*d.*, was produced, and an iron mould made from it, which cost about 30*s.*, and two days afterward I held in my arms the first baby glass sleeper; but so heavy was this first-born, that it suddenly slipped from my grasp and fell with a heavy thud upon the flags. I feared for the safety of my darling's carcass, but upon careful examination I found it to be unimpaired. There its longitudinal form lay upon the ground, not dead, but a veritable sound sleeper, still living, and probably worth more than a dozen dead ones."

Whether Mr. Bucknall succeeds in making railway sleepers or not, if this toughened glass be really as sound and good as is claimed, it must succeed for numerous purposes We must learn to look upon all new things with a liberal spirit, knowing as we all do the exertions of a single individual in condemning a good thing usually reverts upon his own head. I am sure of one thing, that Mr. Bucknall's invention can do me no harm, and I wish him as much success with his glass as I have had with my wrought iron sleepers upon the North-Eastern Railway. There is plenty of room for us all.

THE DELAWARE RIVER GUNNING SKIFF.

THE months of September and October are welcomed by the sportsman of the middle portion of the Delaware, and still more gladly by the epicure of Philadelphia, as it is then that the reed bird makes its annual visit as it passes to the rice fields of Carolina, bringing to the one plenty of sport, and to the other a prized and dainty morsel.

The birds frequent the marshes which line both sides of the river for miles below Philadelphia, and feed on the seeds they find there.

A boat is necessary in order to reach them, and the "gunning skiff" or "duck boat," built for this purpose, answers so admirably that it will no doubt find favor with sportsmen in other localities who may try them.

These boats are from 12 to 15 ft. long, the smaller being the best for two persons, while the larger makes an excellent rowboat for hunting, fishing, and pleasure. If used for rowing where there is much wind but in still water, the sheer may be less than shown, and the small deck forward may be dispensed with and a seat put in as in the stern; or if used mostly in rough water, the sheer may be a little greater.

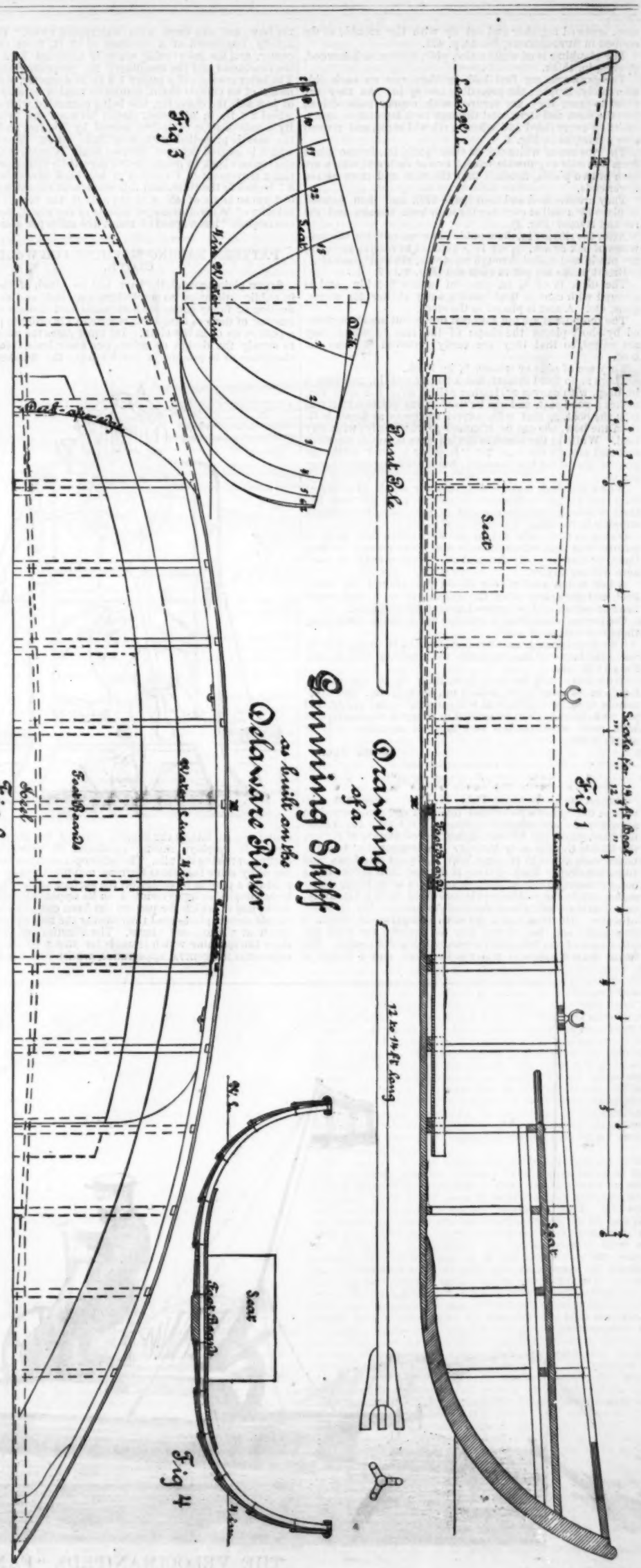
The figures show the mode of construction and the details.

The boat is built on three moulds of the shapes of numbers 4, 7, and 10.

The keel is of oak, ash, or yellow pine, ⅝ in. thick and 6 in. wide for a 14 ft. boat, tapering to the thickness of the stem and stern (Fig. 2), with ⅜ in. rabbets on the lower side for the garboards.

The stem and stern are alike, both ends of the boat being the same, and are of oak or apple, sawed from a knee of the proper curvature.

The rabbets are first cut, and then the keel, stem, and



stern screwed together and set up with the moulds as described in SUPPLEMENT, No 30, p. 471.

The planking is of white cedar, pine, spruce, or basswood, $\frac{1}{16}$ or $\frac{3}{16}$ in. thick.

The garboards are first laid on, then one on each side alternately, lapping the preceding one $\frac{3}{4}$ in. As they are fitted to place they are secured with copper nails driven into the stem and stern, and through each lap at 3 in. apart, omitting every third nail where a rib will come, and riveted over a burr, as in Fig. 4.

The ribs are of white oak or elm, $\frac{5}{8} \times \frac{3}{4}$ in., in one piece from gunwale to gunwale, except two at each end, which are each in two pieces, notched into the stem and stern at the lower ends.

They are steamed and bent (page 472), and then secured in place by a nail at each lap through both streaks and the rib and riveted (Fig. 4).

After the ribs are in, the moulds can come out, and the gunwales of oak or ash, $\frac{3}{4} \times 1$ in., notched to receive each rib, are put in and nailed through topstreak, rib and gunwale.

Breast hooks are put in each end (Fig. 2).

The deck is of $\frac{3}{16}$ in. pine, on carlins $\frac{3}{4} \times 1$ in., and is covered with canvas, thus making a dry shelter for stores, guns, etc. A seat is placed in the stern.

The footboards are not fastened down, but are strengthened by short pieces the shape of the ribs to which they are nailed, so that they are easily removed to clean the boat.

They are of pine or spruce, $\frac{3}{4}$ in. thick.

There is no fixed thwart, but a box 12×14 in. and 7 or 8 in. deep, with canvas or leather nailed over the *open* top, makes a good seat, and can be used in any position that will trim the boat, so that with swivel rowlocks at 6 and 9 ft. from the bow, she can be trimmed to row easily with any load. While in the marshes the oarsman occupies the stern seat and propels the boat by "backing water," while the gunner sits on the box forward; but for rowing they change places.

Where the reeds make rowing difficult, a pole, 12 to 14 feet long and 1¼ in. in diameter, is used to push the boat by, three wooden prongs on the end of the pole preventing it slipping in the mud.

Owing to their light weight and flat bottom they may be pushed over mud where there is not water enough to float them, or may be easily dragged over grass or sedge at portages without injury.

A half round band of iron should run around the stem, keel, and stern; and after the canvas is on a half round bead of oak should be screwed around the gunwale.

Copper nails and brass screws are much better than iron, though a little more costly.

The dimensions given above are for a 14 ft. boat, but by using the larger of the two scales the drawing will answer for a 12 ft. boat.

With ribs ½×⅝ in., keel ⅝ in. thick, ¾ in. × ½ rabbet, lap ⅝ in., streaks ¼ in., nails 1 in., deck $\frac{1}{16}$ in., and footboards ¾ in., the 12 ft. boat will carry two comfortably, and yet be light enough to be carried or dragged anywhere, and with good workmanship and the best materials, will be amply strong.

JERSEY BLUE.

THE VELOCIMANIPEDE.

UNDER the above name, Pablo M. Ruiz, an assistant engineer in the Spanish Navy, has invented and constructed an apparatus for embarkation purposes. We take the following description and accompanying representation of it from the *Revista General de la Marina:* It is composed of two lifeboats, each about 11 ft. long, 1.25 ft. broad amidship, and 10 inches deep. Each of these is divided into three strong compartments, those at the bow and stern being hermetically sealed, while the middle one is provided with a hatchway, raised half an inch above the deck to prevent the entrance of water. Of these boats, the stern compartment displaces 60 pounds, and that of the bow 88 pounds; the total displacement of the four compartments being 296 pounds. The boats draw 6 inches of water at the stern, and 4 inches at the bow, and are lined with waterproof cloth. They are solidly connected at a distance of 2 ft. from center to center, and the intervening space is occupied by a seat for the conductor and the machinery for propelling the boats. The latter consists of a pulley 1·3 ft. in diameter, which, by means of an endless chain, transmits motion to another one of just half the diameter, this being connected with a paddle wheel 2·6 ft. in diameter, placed between the two boats By a combination of levers moved by the feet and hands, the boat is propelled with very little effort. The rudder, which is located between the two boats, is governed by the steersman's back by means of two inverted levers, so arranged that a movement of 1·4 inches of his back gives a swing of 8.7 inches to the tiller, and this movement causes the rudder to form an angle of 45° with the axis of the boat. With a velocity of 56 revolutions per minute of the wheel, the "velocimanipede" has a speed of about five miles per hour.

PATTERN RAISING MACHINE FOR WOOLEN CLOTH.

SINCE plain broadcloths have lost so much of their hold in public estimation as a clothing material, and the introduction of fancy goods for both male and female attire, a number of devices have been resorted to in order to produce a pattern on or in the cloth. In most cases the weaver has to supply the design or color; but sometimes, either for cheapness or to produce a novel effect, the finisher has to

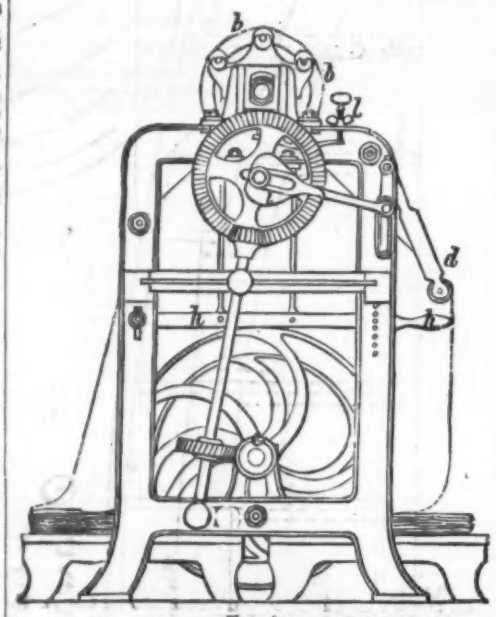


FIG. 1.

contribute, to satisfy the general craving for novelties, the means he employs mostly consisting in embossing and cutting or raising the pile. The latter operation has been made use of by some ingenious German manufacturer in order to produce a pattern or design on the surface of the cloth; this he accomplishes by covering it on its upper side with a thin steel plate in which the pattern has been cut out—in fact, a simple stencil plate—and then raising the nap by means of a brush at the exposed places. The illustrations we annex show the machine which is used for this purpose. Fig. 1 represents the general appearance, whilst Fig. 2 is a section of an important detail, in which *a* is a revolving metal brush, under which the stencil plate, *b*, passes as an endless sheet, guided by the small rollers, *f f g g*. The cloth passes underneath the plate, and has the same speed as this plate; it is carried forward by the guide roller, *e*, which at the same time presses it against the plate. The driving pulley is on the shaft, *e*, from whence the motion is passed on through a diagonal shaft and bevel wheels to the roller, *e*, on one side, and by a strap to the brush on the other side. The brush and the guide roller, *e*, run in opposite directions. The brush is covered in its upper half by a cast-iron cover, which protects it against injury, and at the same time keeps it in the bearings. These bearings are made to slide up and down, and are pressed upward according to want by a set-screw, *l*, acting upon one arm of a lever, whose other arm has a pin pressing on the underside of the bearing. A batching apparatus driven by a heart motion completes the machine.

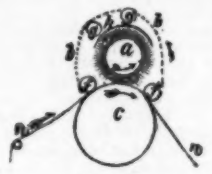


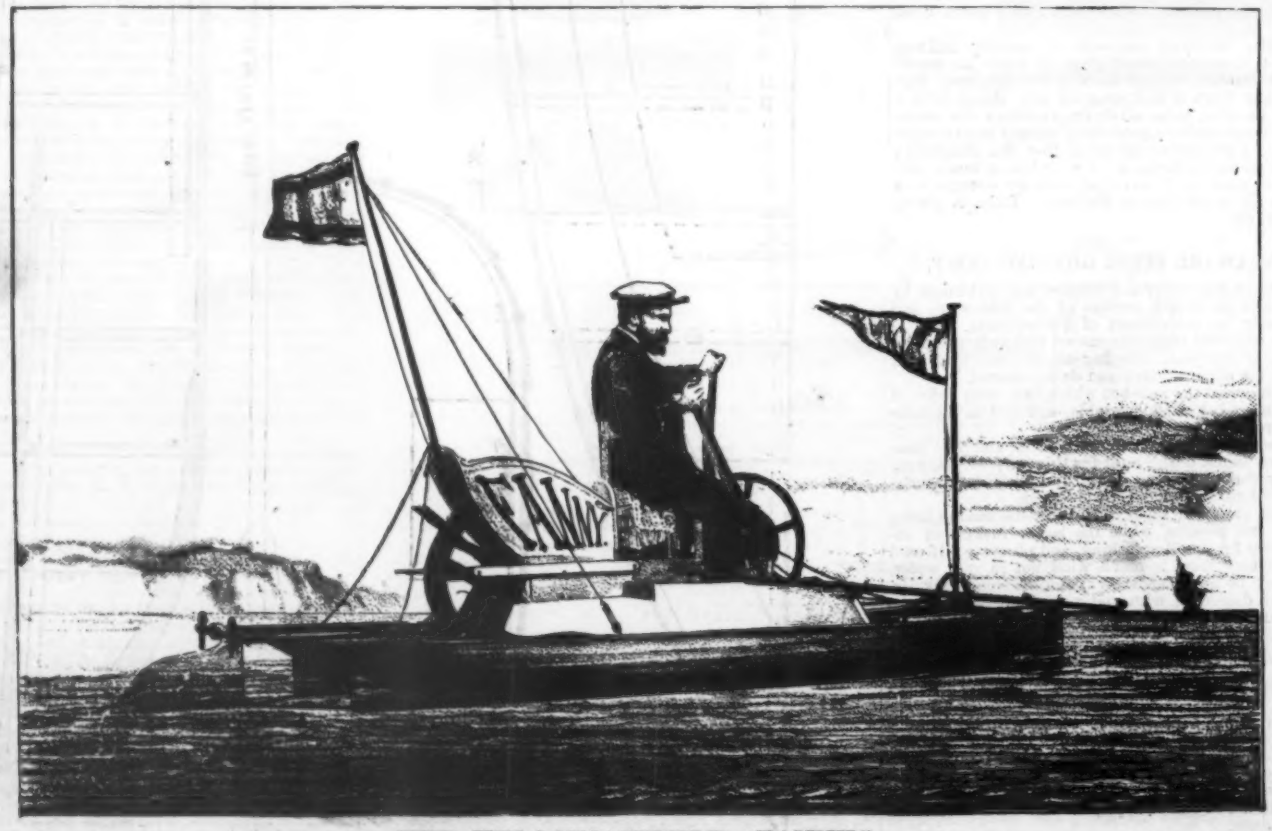
FIG. 2.

The operation of the machine is as follows: The cloth, which has been milled and raised in the usual manner, is introduced with one end between the stencil plate and the guide roller, *e*, and with the nap running in the same direction. The brush, which must be set so that the wires project through the open places in the plate, and ought to run at a high velocity, raises the nap on these open places in a contrary direction to that of the existing nap, and this forms the design, which may be either the roughened or the smooth surface. Where longitudinal stripes of roughened surface are required, it is only necessary to make the stencil plate stationary. The operation seems simple and for some effects will doubtless be efficient; but we are surprised that the price which has been named to us should be so great, so high indeed that it will doubtless act greatly against the introduction of this process.—*Textile Manufacturer.*

PREVENTION OF DOUBLE ROLLER-LAPS AND FOUL PIECINGS IN SPINNING.

OF all things spinners most desire, next to obtaining a good price for their yarn, the prevention of waste of the material and the production of even yarn rank foremost. By many it will be considered an indication of the pressure of the times to find so many efforts made to achieve such results; but we think it trite to remark that the value of these desiderata have always been recognized. At one time a wide field was open to inventors in the requirement of stop motions for textile machinery, to avoid waste and bad work; the ground, however, has by this time been fairly well worked, as many of our readers know.

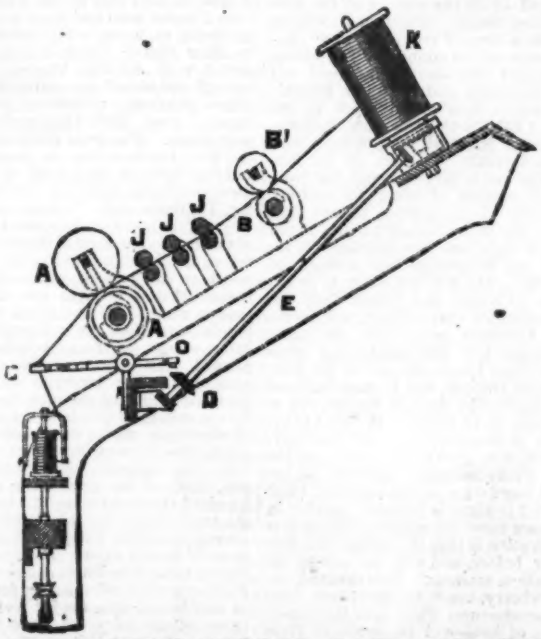
As we shall have to make frequent use of the word "waste," we wish it to be clearly understood in what connection we employ it. In the making of a certain thing, say yarn, the term is somehow made to describe two products entirely different. One of these is strictly a *by-product*, including as it does the foreign substance and defective portions of the raw material, and it will at once be seen that the greater the quantity in which this "waste" is made the better will be the final result. The other kind is waste proper, and consists of good material lost or spoiled in working; it also includes, for want of a better name, what is really good material, partially treated and sometimes capable of being reworked; as an instance, roller-laps in spinning. It is in this sense we use the term "waste." Premising this and speaking in general terms, with reference to no



THE VELOCIMANIPEDE "FANNY."

particular branch of the spinning trade, it may be said that waste and uneven work is most to be dreaded in the finishing processes: for two principal reasons. The waste made in the preparatory stages of the spinning of any fiber is more valuable, because more suitable for subsequent reworking, than that produced later on; in other words, at the commencement it differs but little from the raw material, and may even, up to a certain point, be worth more than it. The other reason why waste in the terminal process of spinning should be the most avoided is that it represents more work thrown away, to be done over again; so that altogether we may say that whilst at this point it costs more, it is worth less for retreatment. Such being the case, it seems very strange that successful stop motions for spinning frames, to prevent the production of roller-laps, have not been invented long ago, instead of being, as is actually the case, of very recent introduction. This is no doubt due to the great difficulty of the problem, which difficulty will be recognized by any one who will ask himself what it is that is required to constitute an efficient stop-motion for a flier or cap frame. The frame may have hundreds of spindles on each side, each supplied with roving by the same delivery and pressing rollers, which are always working. Usually when an end breaks and the attendant does not immediately piece it up, the roving of that particular end will still be delivered, but will not be spun—it will, instead, lap somewhere, either around the delivery rollers or carriers, but mostly around the front pressing rollers. What is wanted is to stop the delivery of this roving until the piecer notices the breakage and repairs it, and this must be done without stopping the delivery of the other ends. In a spinning frame a stop-motion would be worth less than nothing, if when one end fails it stops the motion of the whole machine. We have here the first difficulty: a pair of feed rollers must continue to work but not deliver any roving until the broken end is pieced. As other important factors to be considered, it should be mentioned that the stop-motion should be cheap and simple, not liable to derangement, easily applied to new or existing frames; it should not damage the yarn, lower its quality, or increase the work of the minder; and lastly, the production should not be diminished. Given all these requirements, it ceases to be surprising that the means of supplying them have only recently been discovered.

We have inspected a stop-motion, invented by Mr. Tom Mitchell, of the firm of Mitchell Bros., the well-known mohair spinners and manufacturers, of Bradford, which they inform us answers its purpose perfectly. In their business, the material being in the first instance so expensive, and its waste being worth comparatively so little, it becomes the more imperative that the production of the latter should be reduced to the lowest limit possible. The arrangement may be applied with but little trouble to existing frames. In the illustrations below, the old parts of a worsted frame are shown dotted, and the new in full lines. The top board, it will be noticed, is dispensed with; the delft or pottery eyes for the yarn are fixed instead, in levers, C, balanced in brackets attached to the front rail, as shown. The front pressing rollers, A A, are as usual; but the top carries, J J J, instead of working in pairs, as formerly, are separated, so as to work independently. The bottom feed-roller, B, is *smooth;* it may be made of the old feed-roller shaft, with the flutings turned away. The top feed-roller, B_1, is also smooth, and to dispense with the springs commonly employed it is made solid, and gives the pressure on the roving by its weight alone. The substitution of the old roller weighted with a spring by a solid one acting by its own gravity is regarded as an improvement, because with springs the pressure put on the roving is scarcely ever uniform throughout the frame. The bobbin, K, instead of



PREVENTION OF DOUBLE ROLLER LAPS AND FOUL PIECINGS.

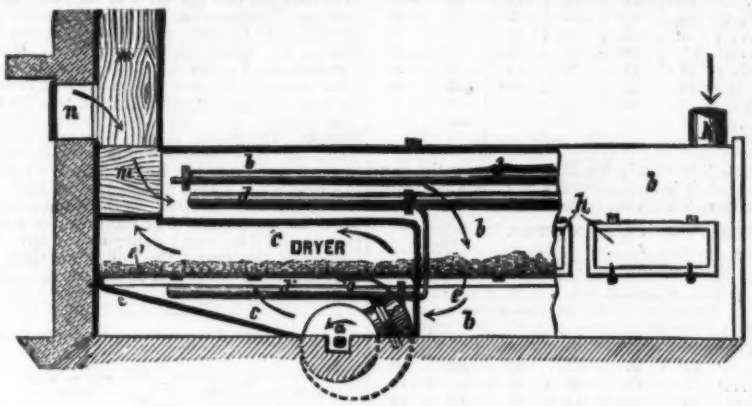
turning in a peg, is mounted, in the arrangement shown in enlarged section, in Fig. 2. A cast-iron washer has two pegs which enter holes made in the bobbin bottom, this washer is connected by bevel gear with a spindle made of stout iron wire, mounted as shown, and carrying at its lower end a toothed wheel, D. Following out the action of this motion it will be seen that, as the roving is drawn off the bobbin, the wheel, D, turns slowly round. But suppose an end breaks, the inner end of the lever, C, being slightly heavier, falls, and engages the teeth of wheel, D, stopping its further revolution, and therefore that of the bobbin, which consequently delivers no roving, thereby preventing the formation of laps and waste. The feed-rollers, B B, continue to work, but being smooth the roving slips between them and is consequently not broken. It might be thought that there is a defect here in the friction of the rollers on the roving, but we are informed that even with the softest Botany roving at present spun, it is found not detrimental to any appreciable extent.

While the main object of the device is to prevent waste, much more rapidly in this than the usual manner, thus saving power and steam. The use of the apparatus simultaneously for the purposes of ventilation is no small part of its merit. By a judicious arrangement of doors and connections, one or more rooms of the mill may have the air drawn from them, or the warm air blown into them, and in the latter case the conduit from the chimney, *m*, may pass through a reservoir of water to moisten the air still more. The apparatus is highly spoken of by a contemporary competent to judge of its merit, and as the idea of it appears to be original, it seems worth the consideration of those interested in these contrivances.—*Textile Manufacturer.*

NICKEL-PLATING TOOLS IN GLASS AND PORCELAIN MANUFACTORIES.—Clemendot recommends very highly nickel-plating iron tools in glass and porcelain manufactories, not only as a protection against rust, but also because the glass adheres less firmly to a nickel-plated tube, and glass objects pressed in nickel-plated moulds appear very smooth and sharp.

DRYING APPARATUS FOR WOOL.

A BERLIN manufacturer, Herr Lohren, has had for some time in use in his mill a drying arrangement designed to economize power, and to serve at the same time as a ventilator for the mill, only one fan being used for the double



DRYING APPARATUS FOR WOOL.

purpose, the principle of the apparatus being to use the same air twice over; the first time it being drawn, and the second time blown through the damp wool.

For this purpose the drying room is divided into two separate chambers, *b* and *c*, each containing a set of steam pipes, marked in our illustration respectively *d* and d^1; the damp wool is, as usual, placed upon wire hurdles marked *e* and e^1.

The fan, *a*, is placed at the junction of the two chambers, and the air drawn by it through the pipe, *f*, from the chamber *b*, into which it enters from the pipe, *k*; air is also admitted at will by the chimney, *m*, which, by means of doors, *n*, may be in communication with different rooms in the mill to be cooled. It will thus be seen that the fan will draw the air downward through the wool, thus drying it, and upward into the chamber, *c*, where it impinges against a plate, *g*, to pass through the hurdle, e^1, and thence into the flue, *m*. The wool is taken in and out by the doors, *h*.

When the wool is not very wet, only one chamber may be used alternately, one being filled while the other is being emptied. It is stated that the process of drying proceeds

LEUCOGEN, SO-CALLED, FOR BLEACHING WOOL.

SOME advantages are claimed, in bleaching wool and woolen goods, for a liquid containing sulphurous acid, introduced into the market under the name of leucogen, over gaseous sulphurous acid, as well as the preparations from which it may be evolved. At an equal cost with the latter, it admits of direct application, without requiring the evolution of gas in closed chambers, and also without the necessity of beating out the goods after drying. For 100 pounds of white material, which should be first thoroughly saturated with water, and still dripping, 6·6 pounds of leucogen and 2·2 to 3·3 pounds of hydrochloric acid should be added to the dye tub filled with pure cold water, and the whole then be slightly blued with sufficient of a liquid consisting of 1,543 grains of indigo carmine (or 246 grains of indigotine), and about 246 grains of aniline violet BBB, dissolved in warm water, well filtered, and diluted with 22 pounds of water. Into this the stuff should then be entered, and reeled for 10 to 15 minutes, then be allowed to remain in it for 3 to 4 hours, then reeled several times, and removed, and dried. For wool the same process will answer, except that more of the ingredients must be taken except of the bluing liquid. The leucogen is said to be also especially adapted to bringing of the white of mixed goods, and imparting liveliness to the whole. Two baths are needed for this purpose, one consisting, for 100 pounds of stuff, of a solution of 3½ ounces of permanganate of potash in some warm water, added to pure cold water in the dye tub, in which the pieces are well worked for half an hour, until they are uniformly saturated, by which they acquire a brownish color. They are then allowed to drain, and are well turned in the second dye bath, prepared with cold water, to which 6·6 pounds of leucogen have been added, and enough of the bluing liquid to impart a very slight tint, but no hydrochloric acid. After remaining in this for an hour they are again turned several times, and removed, and allowed to drain and dry.

[FROM THE PRINCETON REVIEW.]

COMPARATIVE VIEW OF AMERICAN PROGRESS.

IF the reader will take the trouble to glance at Walker's Statistical Atlas of the United States, he will observe that, prior to the Louisiana purchase in 1803, the United States was bounded by the Mississippi River on the west and the Spanish possession of Florida on the south. The cession of Louisiana gave us all west of the Mississippi and north of the Red River, and of Mexico to the Pacific Ocean—a territory considerably exceeding the previous Union. The annexation of Texas in 1845, and the Texas cession of 1850, added a domain nearly equal to the States north of the line of the Ohio and east of the Mississippi; and the first and second Mexican cessions of 1848 and 1853 completed the line of our "scientific frontier" by giving us a territory about as large as the States south of the Great Lakes and east of the Mississippi. The United States of 1800 was therefore a country only one-ninth as large as the United States of to-day. The center of population is moving steadily westward. In 1800 it was on the meridian of Washington; in 1840, of Pittsburg; in 1870, of Cincinnati. In 1880 it may be expected to reach Indianapolis; and, as Mr. Walker prophesies, by the end of the century, the Mississippi River. If we compare the growth of population in the United States with the corresponding results for the population of England and Wales, it will be found that the general rate of growth in America is more than double the highest rate (16 per cent.) of increase in England.

No country in the world ever exhibited such a regular and enormous rate of increase in the population as the United States does from 1800 to 1860. In England the rate increased from 1 per cent. in 1670 to 16 per cent. in 1821, when a distinct and continuous decrease is struck. The rate of 16 per cent. diminishes successively to 15, 14, 13, and 12, until it seems to have approached a stationary condition at 12. In regard to ourselves, the census reports show an average rate of increase of 33 per cent. every ten years. But it should be borne in mind that an increase of population may be deemed a solid good or a dreadful evil according to the circumstances of the country in which it occurs.* If a commensurate increase of food and raiment can be produced by agriculture and by manufacture, an accession of consumers in the home market cannot but be beneficial to all parties, and the increase of population in such case may be deemed equally desirable in itself, and conducive to national strength and national prosperity. In no instance is this better illustrated than in England, where the large manufacturing towns have grown while agriculture has been neglected. Ten years ago Mr. Bright made a series of vigorous speeches embodying advice and counsel to the working classes of Great Britain.† He pointed out to them the mistake they were committing in crowding into cities and engaging in mechanical and manufacturing work to the neglect of agriculture. The burden of the advice was, "Go back to the land." He pointed out how much of the land of Great Britain and Ireland was still lying waste, held as deer forests and grouse moors, which, if cultivated, would maintain directly many thousands, and the produce of which

* Rickman's "Preliminary Observations to Population Abstracts" (1863), p. 30.

† See "The Federation of the English Empire" (*Westminster Review*, July, 1879, p. 29).

would cheapen the necessaries of life to many thousands more who worked in cities. In England, Professor Jevons has very clearly shown that the population is divided into the distinct agricultural and manufacturing masses—contrasted as they are in every point of nature, history, and social condition.* To show that Mr. Bright was right, and that, had his advice been followed, much of the forcing of trade and overproduction of manufactures which has resulted in the present commercial stagnation and disorganization of the labor market might have been avoided, we will compare the condition of these two great portions by means of the rates of progress of some of the most purely agricultural and most purely manufacturing counties:

AGRICULTURAL COUNTIES.

County.	Increase of Population per cent.†					
	1801-11.	1811-21.	1821-31.	1831-41.	1841-51.	1851-61.
Buckingham	9	14	9	6	5	3
Cambridge	18	21	18	14	18	—5
Devon	12	15	13	7	6	3
Dorset	9	16	10	10	5	2
Norfolk	7	18	13	6	7	—2
Somerset	10	17	13	8	2	0
Sussex	10	23	17	10	15	8
Westmoreland	12	12	7	3	3	4
Wilts	4	14	8	8	—1	—2

To demonstrate how clearly Mr. Bright foresaw the dangers that lay ahead, it is only necessary to glance at the following and compare it with the table above:

MANUFACTURING COUNTIES.

County.	Increase of Population per cent.					
	1800-11.	1811-21.	1821-31.	1831-41.	1841-51.	1851-61.
Durham	10	17	24	29	27	30
Lancaster	22	27	27	24	22	20
Monmouth	35	23	20	36	17	11
Northumberland	19	15	11	12	14	18
Stafford	21	17	18	24	20	23
Glamorgan	19	20	24	35	35	37

Thus, while the population in some of the large manufacturing towns in England has increased at the rate of 30 and 37 per cent., 8 per cent. is the highest rate of increase in the agricultural districts, and in three counties the population has actually decreased. But, as Professor Rogers pointed out in the July number of this *Review*, emigration has had much to do with this change. In the sixty-two years from 1815 to 1876 the total number of emigrants who have left the United Kingdom is 8,424,924. Their destinations were as follows:

United States	5,467,075
British North America	1,549,010
Australasia	1,165,628
Other places	243,229
	8,424,942

Taking the money value of these emigrants at $1,000 apiece, as is ordinarily assumed in this country, we find they represent a sum of $5,467,075,000 that English emigration has given the United States. But we find that here, as in England, there is a decided tendency to leave the millions of acres of magnificent lands unoccupied and seek the large towns. Population seems to seek life for the brain, and such excitements as our cities afford prove too attractive for the rural populations, as the following will show:

Year.	Cities and Towns.	Per cent.	Rural.	Per cent.
1850	3,131,675	23·5	10,208,727	76·5
1860	5,081,086	28	13,287,002	72
1870	7,841,950	34	15,215,023	66

No doubt the census of 1880 will show a still larger proportion. In 1850 less than one-quarter of the population of the United States lived in cities; now the towns contain upward of one-third. The change may be to some extent accounted for in the change of the industrial condition of the West, but in general the immense demand for manufactured products which followed the war drafted the country population into the towns, there to exchange the quiet village for the crowded, squalid alleys, the busy workshop, or the gloomy mine. But it must not be forgotten that in the United States there is a happy medium between the large cities and their toiling thousands and the villages with their half dozen stores and schoolhouse. I allude to the manufacturing cities of from 10,000 to 25,000 inhabitants, which are growing up so rapidly, especially in our Western States. Lots are cheap in such towns, and the careful, industrious mechanic soon has a home of his own, and he becomes identified with the city in which he lives.

We are now brought face to face with the real subject of this article—the basis of our prosperity. The actual condition of the United States is generally summed up as follows: The South with cotton, the staple textile fiber of the world's clothing; the West with meat and grain; the Northwest with lumber and leather; the Middle States with coal and iron; New York and New England with textile and other manufactures; the Pacific States and Territories with their vast stores of mineral wealth. But the last ten years has brought about many changes, and the movements of centers of industry make the above statement correct only with many modifications. As Mr. Courtney‡ has shown of England, so in the United States many industries that have died out in one section of the Union have grown up in another. For instance, take the effect of the war from 1861 to 1865 on the production and consumption of domestic cane sugars. The product of the then three sugar-producing States, Louisiana, Texas, and Florida, for the year 1861-2, was unprecedentedly large, and was estimated at upward of 191,000 tons, or 427,840,000 lb. In 1865, however, this branch of industry had become so nearly extinct that it was estimated that no more than 5,000 tons of domestic cane sugar entered into the total sugar consumption of the country. During the last decade the production has rapidly increased.* In the early history of Virginia the light lands of the eastern countries were cultivated in tobacco, extensive shipments to England being made from towns on the Chesapeake, long since abandoned. Less than a century of tobacco growing completely exhausted the coast counties, and left the towns, mansions, and churches that once flourished there buried in a forest of pine. Charleston formerly supplied almost wholly the northern part of Georgia and a large part of Tennessee with nearly everything that the country merchants dealt in, and Savannah shared to some extent in this trade also. The two cities did an immense business. Now the channels of trade have changed with the growing competition of transportation. Trade has been diverted from its former course, and a depreciation of the business interests of these cities has followed. Country dealers are doing a large business, and are supplied directly from the North and West by rail, and new towns are springing up along the lines of railroad. Again, prior to the war the Eastern States alone manufactured textile fabrics. Since that time cotton manufactories have been put into operation in the South and West. Some time ago Tennessee had forty cotton mills, running 56,858 spindles. In Georgia, at Atlanta, Augusta, Columbus, and Macon, are cotton mills. Alabama, Mississippi, South Carolina, and Virginia have mills already in operation. The total amount of cotton manufactured in the South during the year ending September 1, 1879, was 152,000 bales; not a large amount, to be sure, but it indicates the beginning of a change. The South, it has been said, dreams of a period when the vast interest of cotton weaving shall be distributed through the cotton belt itself. The West similarly has faith in a time when it shall monopolize, at least as far as home consumption is concerned, all those manufactures into which wood and iron enter. The fulfillment of both these expectations would silence and depopulate many of the industrial centers of the East. The following table shows that the contingency of a removal of the cotton spindles Southward is remote:

YEAR.	TOTAL TAKINGS BY THE NORTHERN AND SOUTHERN MILLS.		
	Northern Mills. Bales.	Southern Mills. Bales.	Total.
1874	1,177,417	128,526	1,305,943
1875	1,062,522	145,079	1,207,601
1876	1,211,598	145,000	1,356,598
1877	1,288,418	147,000	1,435,418
1878	1,398,298	148,000	1,546,298
1879	1,416,960	152,000	1,568,960

The increased consumption at the South within the last five years has been 7,000 bales; at the North, 354,000 bales.

But that a division of the business of those who work in iron and wood between the East and the West is as remote I do not believe, and indeed the facts indicate the reverse. The West is no longer purely given over to meat and grain. It is growing more important every year in manufacturing; and in industries where recent and reliable data can be obtained, it will be seen that the strides made within the past few years are surprising and worthy of the most careful consideration of political economists. In 1878 the State of Illinois alone made as many rails as the whole United States made in any one year prior to 1860. The four States of Illinois, Wisconsin, Indiana, and Kansas produced last year 266,783 tons of rails, upward of 30 per cent. of all the rails produced in 1878 in the United States. Illinois and Indiana alone produced half a million tons of cut nails, over one-ninth of the total production of the country. The spring of the present year witnessed the starting of new rail manufactories at Omaha, Nebraska, and Centralia, Illinois. The total production of rolled iron of all kinds in the United States for 1878 was 1,555,576 tons; of this, Indiana, Illinois, Michigan, Wisconsin, Missouri, and Kansas produced 232,553, or about one-seventh. The ore in the iron regions of Michigan and Missouri is very rich and free from injurious ingredients, and is capable of being successfully employed for the manufacture of all varieties of iron and steel. Professor Newberry,† one of the best authorities on the subject, has observed that in these two iron districts the inhabitants of the Valley of the Mississippi have a supply of remarkably rich and pure ores, which is not likely to be exhausted for some hundreds of years, and which, from the small amount of phosphorus which they contain, will be the chief dependence of the American people for the manufacture of steel. To Chicago and Milwaukee, and other points on the shores of the Great Lakes, the ore of the Lake Superior iron regions is floated cheaply, and is manufactured where disembarked, or is distributed through the interior of Illinois and neighboring States to be brought in closer proximity to the coal. Already an immense iron rail industry, second only to Pennsylvania, has grown up, based on the relations which have been briefly indicated between the ore and coal. The increase of population on the shores of these lakes within the past quarter century is without parallel in history, and twenty-five years more will witness a still greater growth. The present indication is that the demand for iron will be greater than ever before, and will be met by the Western instead of the Eastern markets. This demand, according to Professor Newberry, must be furnished from three points or lines of manufacture: First, near the mines, where a limited quantity of iron will be produced from charcoal, and coke or coal brought as return freight; second, along the shores of lakes, where the ore is transhipped and meets the coal from the interior, as in Chicago; third, in the vicinity of the coal mines, to which the ore is brought overland by rail, as at Springfield and Joliet. Neither of these points or lines can monopolize the iron manufacture, since return freights must be furnished to empty coal cars as well as empty ore vessels. The preponderance of the lake shores or the interior will be determined mainly by the point to which economy of fuel can be carried in our iron manufacture. With keen foresight and enterprise, the West, and especially Illinois, has taken the newest and now most profitable branch of the iron trade—the manufacture of steel rails. In the manufacture of Bessemer steel rails Cook County, Illinois, has already distanced Allegheny County, Pennsylvania. Last year that great center of the iron trade manufactured 72,346 tons of Bessemer steel rails.‡ Chicago, during the same time, turned out 123,000 tons, and if the neighboring county of Will is counted in, the amount is increased to 178,000 tons, or 33,608 tons more than twice the entire production of Allegheny County. Last year the State of Illinois produced nearly one-third of all the Bessemer steel rails produced in the United States. In other branches of industry the same holds true. A few years ago all our best furniture came from Boston. Said a leading Chicago furniture dealer to the writer the other day, "Not one dollar's worth is now bought east of Grand Rapids, Michigan." The leading hotel at Dundee, Scotland, is furnished from top to bottom with furniture made at Grand Rapids, Michigan; and what is more surprising, this furniture can be delivered in Scotland 25 per cent. cheaper than it can be produced there. A small town in Indiana is now completing a large order for wagons for an English firm, who reship them from Liverpool to South Africa. The proprietor of a Chicago nail works said the other day: "I remember the time when the first nail factory was built outside of Pittsburg. The people of Pittsburg smiled, for they thought nails could not be made outside of that smoky town. But the enterprise succeeded, and as far West as Omaha nails are being made to compete with the East."

While the West is competing with the Eastern States in manufactures, the South is coming into public notice as a fine field for emigration. The following tabulated statement very forcibly indicates that until recently public attention has been singularly diverted from eligible colonizing districts, more accessible than the competing West, both to the great centers of consumption and to the points of vastly increasing foreign shipment of various agricultural products:*

States.	Unimproved Lands.	Percentage of Unimproved Lands in Farms to total Lands in Farms.
Virginia	9,980,871	55
West Virginia	5,948,140	69·7
Tennessee	12,737,936	65·1
North Carolina	14,576,668	73·5
Kentucky	10,556,256	56·6
Kansas	3,685,876	65·2
Nebraska	1,426,750	68·8
Iowa	6,145,326	39·5

Of course it is not claimed that the vast excess of unimproved lands in the Southern States named above has a present productive value equal to the same class of lands in the three Western States. A large proportion of the former is mountain land, both inaccessible and wholly untillable. But the greater degree of intelligence now brought to bear in the cultivation, combined with the discovery in South Carolina of immense beds of mineral phosphates, which, when used as a fertilizer, supply the very element the exhausted lands most needed, will have a tendency to attract settlers. The abolition of slavery will make it less difficult for white emigrants to compete in agricultural pursuits. The mobility of the laboring population of the South not only excluded immigrants from new territory, and prematurely diminished the laboring population of the older States, but in these latter the slaves became massed together as the competition of the richer States of the Southwest came to be more and more felt there. Thus profitable planting required large capital, and small proprietors were at a disadvantage. Free labor was too expensive for both laborer and employer; hence many of the whites were forced to emigrate.† So extensive was this emigration that the census of 1860 showed that of the white persons then living in the United States who had been born in South Carolina, 277,000 remained at home, while 193,000 were permanently settled in other States; North Carolina retained 634,000 and had parted with 272,000; Virginia retained 1,000,000 and had sent off 400,000 of her native white population. The same causes practically prohibited manufactures, because manufactures even more than agriculture depend upon fixity of population. The great development of the manufactures of the West has been due to cheapness of living, uniformity, and regularity in the supply of the necessaries of life; but these conditions were not attainable in the South, where, as Mr. Trenholm says, "a large part of the population was always on the move, and another large part lived in expectation of moving." The want of these manufactures was not severely felt in the South until after the war. Before the war all the Southern energy was put into the cotton crop, and with the money that it brought into the South it was easier to buy than to make. Mr. Atkinson, who has recently visited the South, says that the removal of slavery in the South will bring about the greatest industrial revolution ever accomplished. In this we fully agree with the distinguished economist. The incentive of labor in the South has not been wanting, and the mere fact that the last eight crops of cotton raised by free labor exceed the nine ante-war crops of slavery is alone proof sufficient of the advance in the production of wealth that has already ensued. Georgia invites the emigrant to easy conditions of life. The upper pine lands of the great State are now to be bought by the hundred thousand acres at a half dollar to a dollar an acre—the true country for the abundant production of wool, where no winter shelter for sheep is needed and where all conditions of health exist. The almost unknown valleys that lie between the Blue Ridge and the lateral ranges of Virginia and North Carolina offer homes for hardy men nearer the center of civilization than the far West, but passed by until now because of the curse of slavery. If the well-trained tenant farmers of Great Britain, who are now surrendering their farms, should turn their attention to the opportunities offered in many parts of Virginia, they would find that it needs only brains and industry to put that great State once more on the list among rich and prosperous communities.‡ As Governor Holliday said in his last annual message: "Virginia wants capital. She invites it cordially from beyond the lines. She offers a climate and soil and resources unsurpassed." The able and valuable work§ recently issued by the State of West Virginia gives ample evidence of the vast and hitherto unknown resources of that State. Recent travelers through the State of South Carolina report marked signs of improvement and progress, much of which was said to have been made within the past two years. Property is changing hands to a great extent. Very many of the old property holders have disappeared, and new men are coming to the front. In the interior the indications of

* "The Progress of the Nation," p. 184.

† Census of 1861. Population Tables, vol. i., p. 18. The negative sign — indicates a decrease of population, as in the cases of Cambridge, Norfolk, and Wiltshire.

‡ "The Migration of Centers of Industrial Energy" (*Fortnightly Review*, December, 1878).

* "The Sugar Industry of the United States," by David A. Wells, p. 15.

† "Iron Resources of the United States" (*International Review*, November, 1874).

‡ Address of William P. Shinn before American Iron and Steel Association, at Pittsburg, June, 1879.

* This table is compiled from the U. S. Census Report of 1870.

† "The Southern States: their Social and Industrial History, Condition, and Needs," by W. L. Trenholm, of South Carolina.

‡ "An American View of American Competition," by Edward Atkinson (*Fortnightly Review*, March, 1879, pp. 395, 396).

§ "Resources of West Virginia," by M. F. Maury and W. M. Fontaine.

progress were perfectly clear in the new villages, the new lands in cultivation, and in the really vast amount of new fencing around both the old and the new fields.* Georgia was never in better condition than to-day. Her loans are quoted in New York at $1.11 and $1.12, while her six per cent. bonds are selling in Atlanta at $1.04. Actual figures show† that during the past two years more than 7,000 immigrants have settled in the State of Tennessee through the agency of the State Bureau of Immigration. They have not come as paupers to increase the burdens of the State, but as purchasers of homes. This State needs men of skill, industry, and thrift to occupy its large uncultivated territory. The entire area of Tennessee is 42,000 square miles, or 26,880,000 acres. About 6,000,000 acres are in cultivation, leaving over 20,000,000 acres unoccupied. The labors of the bureau are making Tennessee a formidable rival of States west of it, and with continued efforts the population of the State will be largely increased. Alabama, like the other Southern States, needs immigrants.‡ With a healthful climate, abundance of good and pure water, agricultural fields of rich productive soils inviting labor, mountains of coal and iron ready to be utilized, water courses well distributed all over the State (of excellent capacity for factories), railroads and steamboats to convey the products of labor to market, a well-regulated and fairly administered system of common schools—Alabama is certainly prepared to offer good advantages to those who desire to become citizens of that State. During the past two years it is estimated that not less than 100,000 immigrants have settled in Arkansas.§ North Carolina, pre-eminently an agricultural State, is fairly prosperous.

Stock raising in the South, especially in Texas, affords an immense field for enterprise. The aggregate of Texas cattle is unknown to the best-informed operators. The production of cattle in that State is about half as much as the total production of all Southern States put together. Some idea of the magnitude of this trade may be formed from the fact that, from the Red River in Clay County west to the Pease River and south to the Colorado—embracing a territory of perhaps 25,000 miles—every ten miles square will certainly average 8,000 head of cattle. The increase of cattle is said to be enormous—from 25 to 40 per cent. annually, and frequently it reaches 50 per cent. Mr. Atkinson has pointed out what a field Texas is for German emigration. The German, he tells us, already knows Texas, and in one block of 60,000 square miles of land, by which the State of Texas exceeds the area of the German Empire, we offer more and healthy conditions of life for millions of immigrants; and on that single square of land, if they come in sufficient numbers, they can raise as much cotton as is now raised in the whole South, that is to say, 5,000,000 bales, and as much wheat as is now raised in the whole North, that is to say, 400,000,000 bushels, and yet subsist themselves besides on what is left of this little patch that will not be needed for these two crops. The development of the cotton trade in Texas would necessarily help St. Louis and Chicago. The cotton trade in St. Louis has increased from 36,421 bales in 1872 to 330,088 bales in nine months of 1879. The cotton crop of Texas for 1878–79 was about 760,000 bales. The estimate for 1879–80 is 830,000 bales. If the leaders of Southern thought would only turn their attention to these large topics instead of constantly kindling anew dead issues that should be forgotten, the South would, according to all commercial and economic principles, attain to great prosperity—a prosperity which, it has been truthfully observed, cannot fail to be beneficial to the whole country, because it cannot be attained without the aid and concurrence of all.

But the East, as I shall presently show by actual figures, is not retrograding, though its public debts are large and mercantile failures since the panic of 1873 have exceeded by upward of $500,000,000 the business misfortunes of the West. So far as textile fabrics are concerned, it has been shown that the increase in manufacture has been upward of 350,000 bales of cotton in the past five years in the North and only 7,000 in the South. The competition with England in the cotton business has fairly begun, and will be carried on in this section of the country. Not only have we deprived the United Kingdom of 40,000,000 of people as customers, but we are threatening them with permanent active rivalry in outside markets. The consumption of British goods in foreign markets no longer grows at its old pace, and the reason is not far to seek. Her rivals are making greater progress; for, since 1870, Great Britain's annual consumption of cotton has increased less than 400,000,000 bales, while that of the United States has gone up from 928,000,000 bales in 1870, to 1,439,000,000 bales in 1877, an increase of 511,000,000 bales. One of the most gratifying signs of the stability of the East is the fact that, though the American manufactured goods are selling in all parts of the world and competing with goods from European workshops, the wages of our workmen have not been lowered. On the contrary, in the State of Massachusetts, the State of all others most actively engaged in this foreign competition, the average weekly wages of workingmen in manufacturing and mechanical industries, allowing for the advance in the cost of living, were *ten per cent. higher* in 1878 than they were in 1860; no account being made of the fact that the wages in 1878 were paid for fewer hours of labor per week in many industries than were required in 1860.‖ It has also been proved that the workingmen of Massachusetts, in the majority of cases, have the best quality of food, though not in so great quantity and variety as in previous years; that they are practicing a rigid economy in purchases of clothing, drygoods, boots and shoes, house-furnishing goods, and fuel; and that the majority continue to pay their bills promptly. In 1875, out of the 1,652,000 inhabitants of Massachusetts, 720,000 were depositors in savings banks to the amount of $238,000,000. During the last two years the deposits have slightly decreased. In 1876 the saving banks of the New England States and New York had 2,116,619 depositors, whose aggregate deposits amounted to $751,970,432, an average of $355.26 for each depositor. At the same time the savings banks of all France had 2,865,557 depositors, whose total deposits aggregated $132,082,793, an average of $55.80 for each depositor.

(To be continued.)

Two new elements have been discovered in erbene by Mr. Cléve. One of these he names thulium, from Thule, the old name of Scandinavia, and the other holmium, from the Latinized name of Stockholm.

* New York *Herald* letters, April 23, 1879.

† Message of Governor Porter, of Tennessee, 1879, p. 19.

‡ See Message of Governor Houston, 1878, p. 21.

§ Biennial Report of Commissioner of Lands of Arkansas, p. 60.

‖ For a full and, I think, conclusive demonstration of this important fact, the reader is referred to the Tenth Annual Report of the Bureau of Statistics of Labor of Massachusetts pp. 61-95.

INDIAN IDEAS ABOUT THUNDER AND LIGHTNING.

DR. J. G. HENDERSON, in the sub-section of Anthropology, at the Saratoga meeting of the American Association, gave some interesting details of Indian notions concerning thunder and lightning. In the Illinois language the word for thunder is *ka-kiu-yan*, the meaning of which embodies the belief that thunder is caused by the noise made by the wings of a huge spirit bird. It was thus that these Indians satisfied their curiosity in regard to the philosophy of the phenomenon. "An orthodox Dakota Indian," said Judge Henderson, "had the same reasons for believing in the thunder bird that we have for believing that the whale swallowed Jonah."

The author analyzed the aboriginal ideas and superstitions relative to thunder and lightning, the central notions of all being that these manifestations are the direct acts of spirits. Almost all the tribes in the United States believed the thunder to be produced by the wings of a great bird, and that the lightning was the serpents that were invariably connected with the thunder bird. Among the ancient tribes of the Mississippi Valley, the thunder, therefore, soon became a thunder god who could be propitiated by sacrifices. The Illinois Indians offered up a small dog when a child happened to be sick upon a day when there was much thunder, supposing the latter to be a cause of the malady. Many accidents, like conflagrations, were attributed to this angry god, and some tribes did bloody penances in propitiation, often burning to death their own children. Statements that the Indians adored the thunder, however, the speaker believed to be erroneous. It was the cause of the thunder that they worshiped, and before which they burned tobacco and buffalo meat, or cut off the joints of their fingers, or threw their children into the fire, when they were overcome with fear. The Peruvians had as an idol a stone that had been split by the lightning. They offered it gold and silver. The natives of Honduras burned cotton seed when it thundered. Other Southern tribes made no sacrifices on the approach of a storm, but abased themselves in the most abject fear.

The grandest conception of all, the author thought, was that of the Iroquois, who said it was their great god Heno who rode upon the clouds, split the forest tree with thunder bolts, or hurled stones at his enemies. His home was under the roaring Falls of Niagara. He was a patron of husbandry, and in the spring he was invoked to water and nourish the growth of their productions, while at the harvest festival they gave him thanks for rain. He was also the avenger of evil deeds, and the Iroquois trembled when his deep shout was heard rolling along the firmament. In Brazil, the thunder and thunder god occupied nearly the same place, and the author dilated upon the connection between this idea and the notions of fire stones (flint, chert, etc.), which runs through the whole Indian mythology.

Some tribes give this god a sling with which to hurl the stones. In this way he explained the process of thought by which the thunder spirits came to be the war gods of the Dakotas and other tribes from whom were received the tomahawk, spear heads, and other weapons of flint, and those supernatural paints which should protect them from the murderous shafts of their enemies. The wild rice being aquatic and looking like an arrow or spear, is also attributed to the thunder spirit as to its origin. In Mexico great temples were built upon the sacred spots where lightning had struck. A curious notion among Peruvians was that the preserved bodies of twin children who died in infancy should be worshiped, supposing the father of one of them was the son of the thunder, the origin of the idea being the fact that the thunder god of that people was one of the celestial twins Apocatequil and Piquerad. This tradition was utilized by Pizarro's missionaries to teach the Indians the doctrine of the Trinity.

In the thunder some of our Western tribes recognize the admonition of the Great Spirit of the Four Winds, that the time of corn planting was at hand. But the main and ruling idea everywhere was that the cause of thunder was a bird under various disguises. They described its form and abode and food variously. The different shapes and habits were compared and analogies pointed out. Many professed to have seen it, or its feathers, or tracks, and some professed to have found its nest on pinnacles of the rockiest mountains. Usually it was described as compounded of parts of a man and parts of a bird, and it was the young birds which were charged with the mischief when the lightning did any harm. Judge Henderson thought if there was to be found any resemblance to an earthly bird the night hawk was the species that had originated the idea.

Notwithstanding the thunder was so feared as a god, there were warriors brave enough to defy him, and the Sioux have an association whose exclusive privilege it is to fight the thunder. Instead of propitiating they resisted in mock battle the advance of the storm cloud. The Southern Indians behaved similarly, according to old writers. This introduced a very interesting account of "rain doctors," and the other charlatans who engaged to produce fine weather. Passing over many interesting details, the theories of the manner in which the noise of the thunder occurred next claimed attention, and were discussed minutely in respect to curious details. The paper closed with a recapitulation and general observations upon the Indian method of reasoning correctly but from false premises.

FLIGHT AND ITS IMITATION.

By FRED. W. BREAREY, Hon. Sec. Aeronautical Society of Great Britain.

THE persistence with which men in all ages, so far as history travels, have pursued the study of flight, proves that there is a better foundation than the mere wish to fly in favor of their aspirations. The hope has outlived the empirical attempts of our progenitors. The same examples of flight are presented to us as to them. We have equally looked upon accomplished facts, viz., the transportation of heavy bodies in a medium so thin that we breathe it.

Some time previously to the Montgolfier discovery, M. Blanchard had made several unsuccessful attempts at flight by means of wings. He hailed with renewed hope the invention of the balloon, by the aid of which he thought that he could attain the buoyancy denied to him by the manipulation of wings alone; not only, however, is buoyancy destructive to mechanical flight, but the magnitude of the means employed to obtain it dwarfed all his apparatus. The effort at flight was imperceptible; and at length he used his wings in beating the air so as to retard descent, which in some cases he no doubt achieved. The balloon remains as an aid to man, not yet sufficiently utilized, although in the sense of aerial navigation its scope is too limited ever to be of commercial utility. The bird in the air, however, still continues to present itself a living witness and fulfillment of a great mechanical problem up to the present time unadapted to man's aerial transit. All the great inventions by which the world has benefited have been worked out in the study, and often in the ill-supplied workshop of the man of science, sometimes for ages before the money maker deemed them worthy of his attention. And so, during these latter years, the subject of aerial navigation has been approached with the certain knowledge that if its solution lies in the adoption of mechanical means, in compliance with mechanical laws, then the problem must of necessity be solved by the increased and increasing knowledge and intellect of man. What, then, is the foundation for the hope that man will ever be able to navigate the air? First, of course, the fact that creatures possessing weight are endowed not only with perfect adaptation of means, but with the mechanical instinct to put them to use without waste. The students of aeronautics say that they can imitate such means. It is clear, however, that to construct the required apparatus, without the attainment of precise knowledge as to the work which the apparatus is to perform, would be useless labor. Societies have been formed to discuss the mechanical conditions. The Aeronautical Society of Great Britain, of which I have the honor to be honorary secretary, was formed immediately after the subject was introduced by me in a paper read before the British Association at Birmingham, in 1865. The papers and discussions, printed in our annual reports, have thrown much light upon the action of a bird's vibrating wing upon the air.

We all know what this thin medium can effect when in motion as what we call wind. Our critics, courteously sometimes, strive to conceal their amusement when we talk to them of one day navigating the air. To them the balloon, being a fact accomplished, presents the only means because of its buoyancy. To them the tornado presents no suggestion.

Ships, trees, houses, and towns may be scattered like sand, but to them no idea is presented. I lately read a report of a hurricane in New South Wales in which the speed and force of the air were carefully taken. For a short time the velocity of the wind was stated to be 153 miles per hour, and the pressure no less than 117 lb. upon a square foot of surface exposed to it.

When speaking to men of science upon the subject of the navigation of the air one often hears the expression: "Yes, I don't doubt that some day or other the question will be solved, but not in our day." This is meant to be an easy and safe way of avoiding the discussion of the subject. The savant smiles, and says, "Good day to you;" and leaves his interlocutor in wonderment that even with his hands well sanded his eel has escaped him. "Not in our day," he repeats, and ponders in wonder as to the true application of the expression by so very learned a man. "Not in our day;" and why not in our day? Has there ever been in the world's history a time so marked by various discoveries and inventions as the present day?

The wonderful grasp which man has obtained of force, of the origin of which he is ignorant and of which he yet makes excellent use for many purposes which were utterly inconceivable a few months or years since, absolutely throws into insignificance the hopes of those who desire, by mechanical means alone, to apply to the air the same conditions imparted to it by the mechanical wing action of the bird, by which it sustains in motion a weight out of all proportion, in human conception, to the surface of its wing; yet in exact proportion to the requirements of sustentation and progression in the atmosphere. The mechanical conditions of flight must, therefore, be thoroughly understood before they are attainable.

To imitate nature is a natural and laudable aspiration, and it would appear more hopeful to strive after success in obedience to a precedent, than to attempt to put in harness an unknown power for the accomplishment of objects for which in nature there is no visible or tangible precedent whatever.

I venture to say that if certain recent discoveries had been published for centuries previously, as objects to be attained by constant study and application, the uninstructed portion of mankind would have held in derision the notion of a future for the electric telegraph, the phonograph, the phonoscope, and the telephone.

Resistance is no less caused by a surface in motion against the air than by the air in motion against the surface; with this great advantage in favor of the surface moving against the air, that the speed and pressure can be regulated to the point of efficiency and safety. It is this resistance which the bird creates for itself in the calm of a sultry summer's day by the agitation of its wing surface; in obedience to which certain mechanical actions are evoked, tending to impel it through the still air. The resistance to the down-stroke of the wing and the resistance to the up-stroke are resolved into a sustaining and propelling power. It is conceded that any mechanical conirivance which will cause the resistance encountered by the up and down stroke to be resolved into a single force, must in air have the effect of flight, other matters being in accordance.

But, apart from theory, let us see what is the precise action of the air when agitated by the up and down stroke of a wing. We need not theorize here—we can submit the matter to ocular demonstration, and the effect is conclusive as well as surprising. Not to my knowledge has any similar explanation been afforded.

Take the natural wing of a bird—in my experiments I used the wing of the carrion crow, in length twenty inches; approach a gas flame, and wave the wing, presenting to the flame the anterior edge, commencing at the base, and drawing it toward you until the tip is reached. It will be observed that the flame is sucked in underneath the wing in both the up and down stroke throughout its whole length. Now present to the flame the posterior edge; the same action is observable in both the up and down stroke, until near the tip, where the flame will alter its behavior and be forcibly expelled, the strong current effecting sometimes its extinction.

Here we have the bulk of the wing surface rendered effective in support, in both the upward and downward action, while toward the tip of the wing resides the propelling action.

The great difficulty which the inventor has met with in his desire to encounter the atmosphere in the manner of a bird has faced him at the very first step; it is, we may say, the goose step, the first step in flight—flight itself by simple wing action. We have, however, latterly attained to this, and have thereby assured ourselves that those natural flying machines—the birds—are not supported and propelled by some occult agency unrecognized in any school of science.

That no highly rarefied air in or about the body of the bird is essential to flight.

That no arrangement of feathers so that in the upward stroke the air shall pass through them, while in the reverse stroke they shall be impervious to its passage, is necessary to accomplish an imitation of flight. I have shown many examples. When, however, we come to the transport of weight by such artificial means—such weight, for instance, as is presented by the living prototypes whose shape and proportion of wing we attempt to imitate, such as the rook, the blackbird, swallow, or albatross, with twelve feet stretch of wing—we become perplexed, or, rather, we have hitherto been perplexed, because it is the object of this paper to show that this difficulty is receding before the more perfect knowledge which is always attainable by those bulldogs of science who are determined to retain their grip of an object of which they have once realized the flavor.

Experiments with the wings of the dead bird have hitherto been unsatisfactory.

I have myself not been successful in attaining flight by the attachment to my apparatus of any birds' natural wings. I attribute this to the absence of that elasticity which pertains to the living prototype. The best examples of flight by models, which I have yet attained, are in those instances where the wings have been made more than usually flexible. This is an encouraging feature, because the manufacture of a rigid wing of the dimensions necessary to support a man would necessitate great weight; in fact, it would be impossible to control its action by any motive power without great danger of fracture. I have seen such a wing fractured at the first stroke.

The apparently insuperable difficulties attending the accomplishment of manual flight by wing action have stimulated efforts in the direction of plane surfaces propelled by screws.

The late Sir George Cayley, a Yorkshire baronet, well known for his persistent experiments for the attainment of locomotion in the air, states, with respect to plane surfaces: "About sixty years ago, many experiments on a large scale were made by this means, some of the aerial vehicles having three or four hundred feet of canvas extended on masts, and braced by rigging, and a surface of fifty-four square feet, weighing 11 lb., was found to support 126 lb. in its waft. These trials proved in a most decided manner that perfect stability and guidance were attainable.

"For instance, it was proved that a man placing himself on a machine of proper dimensions for his weight, at the top of a mountain, say one mile above the level of the plain below, might in calm weather, with steadiness and security, proceed through the air to any place he might choose to steer, about eight miles in a horizontal direction. Of course, the line of flight would be in a continuous descent of 1 in 8, gravity being the only cause of the motion of the machine."

So that the propulsion of such a surface is not a preposterous idea. Mountain tops, however, are ideal in the majority of localities, so that, in order to find a substitute for that rarity, it was gravely proposed by a gentleman who called himself a civil engineer, that the line of flight being first determined upon, high towers should be erected at suitable distances, from the top of which a machine of considerable dimensions, with passengers, might be started, and so steered to the foot of another high tower, to the top of which the machine could be hauled, while the passengers walked up the stairs, and were launched to the foot of the next high tower!

To avoid high towers and mountains must of necessity become the aim of the plane propeller, and there is just this difficulty: Can he by any auxiliary power leave the ground by rising in the line of least resistance?

Well, this has never yet been accomplished. No speed that has yet been attained on the level road, or even down an incline, has hitherto proved sufficient to enable a surface advanced at any angle against the air to leave the ground and complete its flight in the air. Of course there is a velocity relative to weight and surface which will affect this achievement, and as an experiment it will no doubt be effected, but when done it will only class with balloon propulsion. It has been shown that, as a fact, the balloon can be propelled, and when the attainment of a speed of six or eight miles an hour in a moving body of air of varied velocity, whose direction may or may not be in favor of the desired course, will conduce to the object sought, then the knowledge may prove useful, and the expenses connected therewith may count for nothing in view of its importance.

That which I have advanced respecting the plane relates only to the stiffened plane surface propelled at a fixed inclination against the air. The conditions would, I believe, be quite altered if the plane surface could be made to assist itself during its preliminary run; and I think that I am justified in my opinion by reference to some long-winged birds that effect their rise from the ground, not alone by extending the wings as planes, but by using the air as a fulcrum which is increased in solidity by the multiplication of the vibratory wing action.

Mr. F. H. Wenham, in the first paper read before the Aeronautical Society, speaks of the eagle which he sees sitting in solitary state in the midst of an Egyptian plain:

"An approach to within eighty yards arouses the king of birds from his apathy. He partly opens his enormous wings, but stirs not yet from his station. On gaining a few feet more, he begins to *walk* away. Now for the chance fire. A charge of No. 3 from 11 bore rattles audibly but ineffectually upon his densely feathered body. His walk increases to a run, he gathers speed with his slowly waving wings, and eventually leaves the ground. Rising at a gradual inclination, he mounts aloft, and sails majestically away to his place of refuge in the Libyan range, distant at least five miles from where he rose. Some fragments of feathers denote the spot where the shot had struck him. The marks of his claws are traceable in the sandy soil, as at first with firm and decided digs he forced his way, but as he lightened his body and increased his speed *with the aid of his wings*, the imprints of his talons gradually merged into long scratches. The measured distance from the point where these vanished to the place where he had stood, proved that, with all the stimulus that the shot must have given to his exertions, he had been compelled to run full twenty yards before he could raise himself from the earth."

Thus nature teaches us; but there is such an infinite variety in the mode of flight, and in the manner of progression, both in water and in air, that though we may never get the proverbial pig to fly, we may possibly be able widely to depart from any known form.

The difficulties which inventors have foreseen, and sometimes encountered without foresight, are: the construction of wings which shall be of the great lateral extension considered to be necessary; strength of structure; ability to manipulate them. The preservation of a certain amount of rigidity throughout the whole length, decreasing toward the tips, and especially so between the anterior and posterior portions of the wings' edges—the great strain upon the posterior edge, which cannot be framed to any attachment without destroying the whole principle of action—and the small amount of sustaining surface by reason of the comparative narrowness of wing, under which it is impossible to see safety unless by the preservation of an acrobatic balance.

All these considerations have militated against the employment of wings for progression and support upon the air.

It is evident that if the wing surface could be extended longitudinally and there attached, something like the small end of a kite, to the extremity of its backbone, thirty feet behind, the surface thus exposed might be made ample enough to sustain man and motive power. In fact, it would be easy so to extend 300 or 400 feet of canvas by wing arms, twenty feet long from tip to tip; but *the surface would not be in tension.*

It may have been observed that the best flying kites are those which "belly" with the wind, or, in other words, form a concave toward the wind. Would such an arrangement prove effective? If so, then I can see safety under such an extent of surface. I can also see that this surface would take a concave form in its descent, and so prove to be a longitudinal parachute which would bring a weight down in perfect safety.

Is there any example in nature which would warrant the supposition that such an arrangement would be effective? Well, if we go to an aquarium, and watch the mode of progression of some fishes, we shall find that some of the flat fish—notably the skate—progress by a wave-like action of the whole of their bodies. We cannot, of course, impart a wave action to the framework which shall extend our canvas, but we can do so to the canvas, and the question arises, Will a surface so vibrated support as well as propel? I can aver that a model made upon this principle, which I discovered for myself, behaved in a perfectly satisfactory manner. The wave action is imparted to it by the vibration of two wing arms, which cause a succession of waves to flow from the front to the extreme end; and I find that it will not be difficult to manufacture those arms twenty-four feet from tip to tip, light, elastic, and incapable of fracture, consisting, as they will, of bundles of canes wrapped together firmly, from base to tip, with whipcord, and tapering the whole by cutting off a cane every foot or so. My idea is, that if the whole were placed upon wheels, and a wave action imparted to the fabric by steam or compressed air, it would perform much the same feat as Mr. Wenham's eagle. The parachute action upon cessation of motion leaves nothing to be desired, amenable as it is to proper management in the disposal of the ballast.

The sustenation of a weight in flight by wing action depends entirely upon power, strength of material, and surface. As power and strength are increased, the surface may be curtailed. I scarcely, however, dare to hope for any such result as spoken of by Sir George Cayley, for in that case I might expect that 400 square feet of canvas would support more than 800 pounds.

The surface, however, being its own propeller, satisfactory results may be expected. I have a model, for instance, of the dimensions of an albatross. Now if it is supposed that a fabric is attached to the wings, from tip to tip, and from thence taken to the tail, we should then have a comparatively loose surface, having no intermediate support but that afforded by the central shaft. Upon the waving of the wing arms we should then get a wave action longitudinally as well as laterally.

This double action proving effective we might then have above us a cloud of canvas, supporting and propelling, and presenting an extent of surface that would look more like safety than anything which has hitherto come under my notice. To these advantages may be added the statement that for aerial transit it would be only necessary to clear obstructions, and that those highly-colored pictures of so-called "aerial machines," "up above the world so high," do not represent faithfully our aspirations.

I have now given the reasons for the ambitious hopes that some of us entertain, and I conclude with the expression of a desire that more minds may be directed to the attainment of our objects.—*Popular Science Review.*

[Continued from SUPPLEMENT, No. 206.]

PRACTICAL EXPERIMENTS IN MAGNETISM, WITH SPECIAL REFERENCE TO THE DEMAGNETIZATION OF WATCHES.

By ALFRED M. MAYER.

On the Magnetization and Demagnetization of Steel.—To understand thoroughly our process of taking the magnetism out of a watch one must be in possession of certain facts which have been discovered about the magnetization and demagnetization of steel. These facts I will now give.

Fig. 31.

Let A B, Fig. 31, represent a piece of steel laid on the table. N is the north pole of a bar magnet, which is held vertically over the end, A, of the piece of steel. Bring the end, N, of the magnet to touch the end, A, of the steel and slide the magnet over the steel, in the direction of the arrow, to the end, B. Slide it off the end, B, and lifting it in the air, again bring N down on A, and repeat the operation. Even after one stroke of the magnet on the steel, the latter will be found to have received a charge of magnetism, which generally increases in strength up to a certain number of strokes of the magnet; after which further strokes of the magnet have no effect in increasing the magnetic charge in the steel. On now taking the steel, A B, to the magnetometer and testing its magnetic condition, as has already been explained in Figs. 7 and 10, you will find that the end, B, of the piece of steel is of S. magnetic polarity. If the bar magnet, N, strokes the steel from B to A, then B will be found of S. magnetic polarity. In other words, it is a general law that the end of the piece of steel *toward* which the magnet slides is of the opposite polarity to that of the end of the magnet which stroked the steel.

It is, however, not necessary for the magnetization of the steel that the magnet should rest on it while it glides over it. If the magnet be strong enough, and if the steel be not too hard, the latter may be magnetized by passing the magnet along the length of the needle and at some distance above it, as shown in Fig. 31.

Let N, in Fig 32, stand for the N. end of a magnet, while A B is a piece of steel which has been brought near to the end, N, of the magnet. If the magnet be strong, and the steel of the quality of sewing needle steel, that is, not too hard, you will find on testing the steel, A B, at the magnetometer, that the end, A, which faced the north end of the magnet is of south polarity, while the end, B, is of north polarity. If the piece of steel, A B, had been brought near the south end of the magnet, instead of the north end, then you would have found that the end of the steel which had been nearest the south end of the magnet was of north polarity. In other words, when a steel rod is brought near a magnet it is magnetized, and the end of the steel rod nearest the magnet is of a polarity opposite to that of the end of the magnet toward which the rod points.

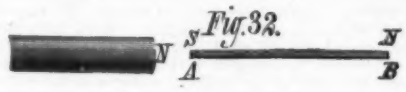


Fig. 32.

If, instead of holding the steel rod at a distance from the magnet, we bring it to touch its end, then the magnetic charge given to the steel will be greater than in the former experiment. The polarity given to the end of the steel which touches the magnet is always opposite to that of the end of the magnet touched.

So much for the magnetization of the steel rod. Its demagnetization consists in taking the magnetism out of it, and is effected by operations similar to those just described in magnetization. These processes we had better describe by the aid of Figs. 31 and 32.

In Fig. 31, let A B be a magnetized rod of steel, with its north pole at A, its south pole at B. We have found out that this rod was magnetized, with its poles as just described, by stroking it from A toward B with the north pole of the magnet, N. The reverse direction of stroking will demagnetize it, that is, if the north end of the magnet be drawn over A B, from B toward A, then the magnetism will disappear from the rod, A B; and if the operation is repeated after the magnetism has disappeared we will even remagnetize the rod; but this remagnetization will place its north pole at B and its south pole at A.

It is not necessary, however, that the magnet should touch the steel rod during the operation of demagnetization. It is sufficient, if the magnet be powerful, to pass it over the steel rod at a distance above it and in a direction always opposite to that in which the magnet moved when it magnetized the rod.

In Fig. 32, let A B be a magnetized rod of steel, having its south pole at A and its north pole at B. This condition of magnetism has been given to it by the presence of the north pole of the magnet, N. Now, if we take away the magnet, N, and then bring up to the bar, A B, the south pole of the magnet we shall find that the rod, A B, will be demagnetized. If the rod, A B, be of very hard steel and the magnet not very powerful, it may be necessary for the magnet actually to touch the rod, A B, in order to demagnetize it.

Here it is in order to describe more explicitly the operation of demagnetization. To demagnetize a rod does not require as strong a magnetic action as that which was required to give the rod its present magnetic charge. So, in performing the operations of demagnetization, we should be careful not to give too many reverse strokes to the rod, nor to approach it too near to the demagnetizing magnet. It is better to pass the magnet over the magnetized rod at a short distance above it, and after such operation to test its gradually falling magnetic charge at the magnetometer. The critical point is when this residual charge becomes small; for then the danger is that you will not only demagnetize the rod by the next operation, but will actually remagnetize it, with, of course, its poles reversed.

In the course of my experiments on the demagnetization of watches I made a series of novel experiments on the demagnetization of steel rods placed at right angles to the demagnetizing magnet. The steel subjected to experiment was of the hardness of that of sewing needles. These experiments explain some curious facts in our mode of demagnetizing watches, and therefore form a natural introduction to the practice of our process.

The rods of steel on which these experiments in demagnetization were made were formed of pieces of No. 1 sewing needles. The points and eyes of the needles were broken off, thus leaving rods of about two and one-eighth inches long. The rat-tail file magnet was used for the demagnetizing magnet.

The manner of experimenting was as follows: The needle was magnetized by stroking it repeatedly with the end of the magnet. It was then placed pointing toward the center of the magnetometer needle and at right angles to the magnetic meridian. In this position the needle produced a certain angular deflection in the needle of the magnetometer. The needle was now placed in an upright position, as shown at *n s* in Fig. 33. The demagnetizing magnet, N S, was

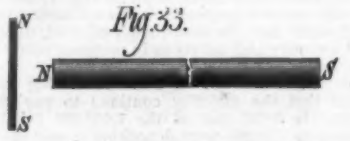


Fig. 33.

mounted on a block which slid between guides, so that the magnet, N S, could be gradually brought up to the needle, *n s*, and during all the time of its approach the axis of the magnet, N S, pointed toward the center of and at right angles to the needle, *n s*. The approach of the magnet to the needle in these circumstances was found to have lowered the magnetic charge of the needle, and this took place even when the greatest care had been taken to have the magnetic axis of the demagnetizing magnet at right angles to the *magnetic center* of the needle, *n s*. The following table will show the manner in which the magnet, N S, demagnetizes *n s* when the former approaches the latter.

After the needle was magnetized it deflected the magnetometer	22°
After the magnet had been placed 1/4 in. from needle,	18°
" " " " 1/4 " "	18°
" " " " 1/8 " "	15½°
" " " " 1/8 " "	15½°
" " " " 1/16 " "	12°
" " " " 1/16 " "	12°

Examining the above record of the experiments it will be seen that the approach of the magnet to one quarter of an inch of the center of the needle brought down its magnet charge from 22° to 18°, and that a repetition of this experiment had no further effect in demagnetizing the needle. The same is observed on the repetition of the experiment when the magnet was placed at one eighth and one sixteenth inch from the needle. The total effect on the needle of the presence of the magnet at one sixteenth inch from its center was to lower the needle's effect on the magnetometer from 22° to 18° of deflection. Of course it will be understood that in any one series of experiments the end of the needle was always placed at the same distance from the center of the magnetometer needle.

In another series of experiments the needle had its magnetic charge lowered from 61° to 35° deflection on the magnetometer.

The reader will be careful to observe that I have stated that in these experiments I took every care to have the magnetic axis of the demagnetizing magnet at right angles to the magnetic center (or equator) of the needle. If this could be really done it might be a question whether the magnet would have any effect on the needle. Yet, all of our experiments show that it *always* has an effect of demagnetization. For a long time it has been known that for the demagnetization of a magnet it requires a far weaker magnetic action than that of the magnet which gave it its magnetism; now when the magnet is at right angles to the needle, as in Fig. 33, the north pole, N, of the magnet acts *equally* on the two poles of the needle, *n s*. It tends to repel the magnetism in *n* and hold that in *s*. It may be that the freeing power of N on the needle is greater than its holding power. It is also here to be stated that, in a long series of experiments made exactly as described above, only with the demagnetizing magnet two feet long and the needles one quarter inch thick and six inches long, and hardened to the greatest degree possible before magnetizing them, this large magnet had no effect whatever on these *intensely hard needles*, though every care was taken to get the magnetic axis of the demagnetizing magnet truly at right angles to the axis of the needles and pointing toward their centers.

We will now describe another series of experiments in demagnetization in which the needle is *rotated* before the pole of a magnet, with the center of the needle on a line in the prolongation of the axis of the magnet. In Fig. 34, N S is the demagnetizing magnet, and *n s* is the needle operated on. The following description of one of the series of experiments will give an accurate idea of all of those made:

The center of the needle, *n s*, was one inch and three quarters from the end of the magnet, N S. After the needle had been magnetized it was placed opposite the magnetometer, and caused a deflection of 61° in its needle. The needle was now placed in a vertical position at right angles to the magnet, N S, and with its center one inch and three quarters distant from the end, N, of the magnet. The needle was now turned around its center so that its south pole went through 90°, and approached the north pole, N, of the magnet. The magnet was now removed and the needle tested at the magnetometer. As might have been expected it produced the same deflection of 61° as it did before the experiment. The needle was again placed in its old position, the magnet brought to the same distance from its center, and the needle again rotated before the magnet; but this time the north pole of the needle turned round 90° toward the north pole of the demagnetizing magnet. After this operation the needle had had its magnetic charge lowered so that it now only produced a deflection of 32·5° in the magnetometer. A repetition of the experiment brought down its magnetic charge to 30°. A third experiment brought it to 27°, while after the fourth experiment its deflection on the magnetometer needle amounted to only 16°. Further experiments had no effect in reducing the magnetic charge. It should have been mentioned above that in all these experiments the needle was really oscillated around its center before the magnet; that is, its *south* pole was always brought before the magnet (this tended to magnetize the needle); then its north pole was brought before the magnet (this tended to demagnetize the needle); then the needle's south pole was again brought before the magnet, and the experiment terminated. Thus we see that the magnet first tended to magnetize the needle, then to demagnetize it, and lastly to magnetize it. Notwithstanding that the needle was subjected to a magnetizing influence from the magnet after its demagnetization, it had its magnetism lowered, so much less magnetic force being required to demagnetize than to magnetize a magnet.

In the following series of experiments the needle was placed as in the preceding experiments, and it was rotated through a whole revolution before the pole of the magnet instead of through only a half revolution as in the preceding experiments. Before an experiment was made on the needle it deflected the magnetometer needle 51°. The needle was now rotated before the magnet through a whole revolution, its south pole approaching first the magnet, then passing it and turning over the circumference of the circle till it had made an entire revolution and had come back again to its first position at *s*, in Fig. 34. After the first revolution the

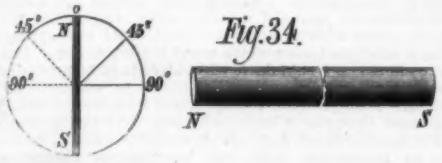


Fig. 34.

needle was demagnetized so that its effect in deflecting the magnetometer needle was only 9°, instead of 51°, the deflection which it caused before it was rotated before the magnet. The whole of this demagnetization was caused by the passage of the north pole of the needle across the N. end of the magnet, N. The passage of the *s*. pole of the needle athwart the N. pole of the magnet could have had no other effect than to magnetize it.

A second rotation similar to the above reduced the deflecting power of the needle on the magnetometer to 5°. A third experiment brought it down to 4°; after which no further rotation had any effect in reducing the magnetic charge of the needle.

ON THE DEMAGNETIZATION OF WATCHES.

The reader who has made for himself the magnetic experiments, which we have so minutely described, or who has even read the accounts we have here given of them, will have no difficulty in seeing the reasons for the various operations which I will now describe in giving an account of the way to take the magnetism out of a watch.

A watch is formed of a case of gold or silver, and glass inclosing brass or nickel plates, between which are a number of steel arbors forming the axles and pinions of the brass wheels. There is also the spring of steel which uncoils itself in the plane of the watch. The older watches have in addition a steel chain which uncoils from the fusee on to a brass barrel inclosing the mainspring. The hairspring, parts of the balance wheel escapement, stem winding apparatus, etc., are also of steel. So we see that there is abundance of material for magnetization in a watch. Fortunately these parts are formed of steel which is only moderately hard, and, therefore, as we have already seen, easy to demagnetize.

Of these various parts some have their lengths at right angles to the plane of the watch, like the arbors; others, like the main and balance wheel springs and the nickel (nickel takes a magnetic charge like steel or iron, only feebler)

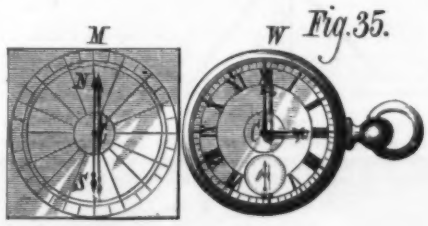


Fig. 35.

plates inclosing the movements, have their greatest dimension in the plane of the watch. The position of these bodies determines to a great extent the directions of their magnetic axes. By magnetic axes we mean an imaginary line joining the two poles of a magnet. The arbors will have their magnetic axes in the direction of their lengths, whereas plates are most likely to have theirs in the direction of one of their diameters. But we have already seen that no matter in what direction their magnetic axes are in the watch, all of these bodies (thanks to the facts already shown in our experiments) may be demagnetized *by properly oscillating the watch before the pole of a magnet*. How this is to be done I will now show, and in order to shorten what might otherwise be a long story, I will give an account of the process by describing the experiments actually made in the course of demagnetizing an old Tobias fusee watch, which I saturated with magnetism by deliberately placing it on one of the poles of the large magnet of my laboratory in the Stevens Institute of Technology, and thus purposely obtained a very badly magnetized watch to practice a cure on.

The watch is placed quite close to the magnetometer, and with the center of the thickness of the watch about on a level with the center of the needle of the magnetometer, and with the line, connecting the center of the watch, C, Fig. 35, and the center, *c*, of the needle, at right angles to the magnetic meridian; in other words, at right angles to the direction which the needle has when no magnetic body is near it. The watch is then turned slowly around on its center as an axis, and each hour on its dial is in succession brought opposite to the center, *c*, of the magnetic needle of the magnetometer.

The following were the results of such experiments on our magnetized watch. We give them in the form of a table: N. and S. indicate the kind of magnetic polarity at each hour, and the angles show the effect in angular deflection on bringing that hour of the dial opposite the center of the magnetometer needle:

TABLE I.

Hour.	Ang. of Deflection of Magnetometer.	Kind of Magnetism.
XII.	20°	N.
I.	5°	N.
II.	18°	S.
III.	72°	S.
IV.	56°	S.
V.	22°	S.
VI.	5°	N.
VII.	17°	N.
VIII.	16°	N.
IX.	16°	N.
X.	20°	N.
XI.	24°	N.

When the hour III. was brought opposite the magnetometer needle the fusee axle and the center of the semicircular steel catch of the inner cover of the works were presented to the magnetometer. The strong south magnetism of hour III. was due to the magnetization of these bodies, which deflected the needle of the magnetometer 72°. The strong north magnetic action of hour XI. was due to the magnetized mainspring.

We may now regard this watch as a magnet, having the form of a disk, and with its north magnetic pole at the hour XI. and with its south pole at III. o'clock.

This being the information given by our magnetometer, we are in possession of facts which enable us to take the north magnetism out of eleven o'clock and the south magnetism out of three o'clock.

You have already found, by your experimenting, that when you bring the north pole of one magnet near the north pole of a more powerful magnet, the powerful magnet will take the magnetism out of the weaker one because it tends to make the north pole of the latter a south pole. Similarly the south pole of a powerful magnet will demagnetize the weaker magnet when the south pole of the latter is brought near the south pole of the former.

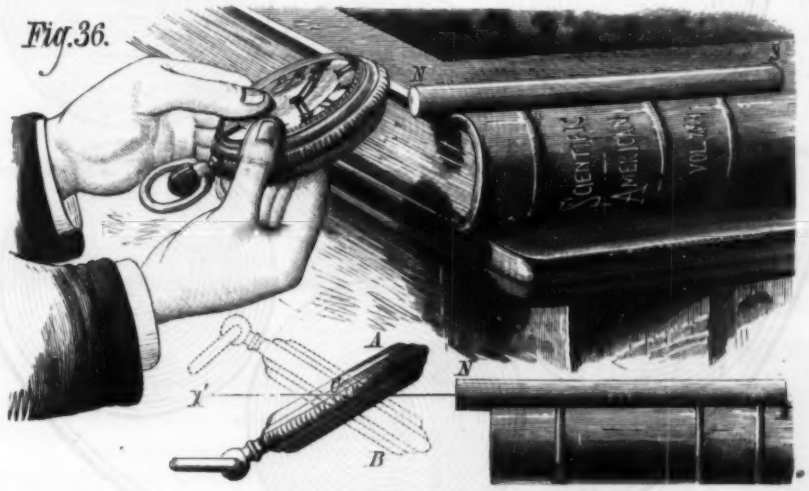
You have also found out by your experiments that when a small magnet, made of steel not too hard, is vibrated around its center in front of the pole of a powerful magnet, the small magnet is demagnetized. These facts show how we must proceed in the demagnetization of the watch.

The hour XI. is of the strongest north magnetism of any on the dial; therefore we place this hour opposite the north pole of our rat-tail file magnet, as shown in Fig. 36. The center of the watch, C, is placed so that the prolongation of the axes of the magnet (shown by the dotted line, X X') passes through it. The watch is now vibrated around an axis passing through C and at right angles to X X'. By this operation the watch is successively brought into the positions, A and B, of Fig. 36. After several vibrations of the watch before the north pole of the magnet, I turned the hour III., of strong south polarity, opposite the south pole of the magnet, and vibrated the watch as in the previous experiment. By these vibrations the watch cuts across the lines of magnetic force, and, as we have seen, any magnetism in it is thus taken out. After these operations performed on the hours XI. and III., the watch was again examined before the magnetometer, and the following table shows the effect of the vibrations before the magnet:

TABLE II.

Hour.	Ang. of Deflection of Magnetometer.	Kind of Magnetism.
XII.	2°	N.
I.	5°	N.
II.	4°	N.
III.	0°	
IV.	5°	S.
V.	8°	S.
VI.	2°	S.
VII.	4°	N.
VIII.	4°	N.
IX.	2°	N.
X.	1°	N.
XI.	0°	

Fig. 36.



DEMAGNETIZING A WATCH.

There is certainly a great difference between the magnetometer deflections of Table I. and these of Table II. It is observed at once that the hours III. and XI., which were respectively of strong south and north magnetism in Table I., are in Table II. marked 0°. This result was not attained, however, at one trial, as might be inferred from our description of the experiments, but after each series of vibrations before the pole of the demagnetizing magnet the magnetic condition of hours III. and XI. was tested. Sometimes their magnetism almost disappeared. Then we found it had changed, or rather inverted, so that hour III. had north instead of south polarity, and hour XI. had south instead of north magnetism. When this happened we had to present hour III. before the north pole of the magnet, the hour XI. before the south pole. After repeated trials I succeeded in demagnetizing hours III. and XI., so that they produced no action whatever, or 0°, on the needle of the magnetometer.

I now again brought the watch before the magnet, and vibrated its V. o'clock before the south pole till this south magnetism had disappeared; in other words, produced no deflection whatever on the needle of the magnetometer. I then made an examination of the magnetism of the watch before the magnetometer, with the following results:

TABLE III.

Hour.	Ang. of Deflection of Magnetometer.	Kind of Magnetism.
XII.	1°	
I.	0°	
II.	0°	
III.	0°	
IV.	2½°	S.
V.	2°	S.
VI.	2°	N.
VII.	6°	N.
VIII.	5°	N.
IX.	2°	N.
X.	1°	S.
XI.	2½°	S.

I now demagnetized hour VII. of its 6° of north magnetism by vibrating this hour opposite the north pole of the demagnetizing magnet, and after I had succeeded in this I

found that no hour on the dial of the watch when presented to the magnetometer caused a deflection of even one degree, so I considered the watch demagnetized, in which conclusion I was justified, for the watch has kept as good time and with about the same rate as it did before it was magnetized.

The "accident" to which I referred in the first of these articles happened to a valuable watch made with special care by Lange, of Dresden. It was so strongly magnetized that IV. o'clock on its dial produced a deflection of 83° south magnetism on the needle of the magnetometer, and VII. o'clock a deflection of 40° of north magnetism. This watch I demagnetized exactly as has been described, and after its demagnetization, though it had lost a half hour in three hours when magnetized, it kept a rate even more uniform than before its magnetization. Before its magnetization it lost about one second per day; after its demagnetization it has gained from ¼ to ½ second per day, and has a very uniform rate, indeed as uniform as one could wish for in a pocket watch subjected to daily vibrations on the railway.

THE MAGIC NEEDLES.

To the Editor of the Scientific American:

My attention has been called to an article in the SCIENTIFIC AMERICAN of August 9th, 1879, in which you say that Silvanus P. Thompson, Professor of Physics at University College, Bristol, England, presented a very peculiar optical delusion at the last meeting of the Société Française, etc. Now, as this was discovered and copyrighted in this country some six years ago, and some cards illustrating it sent over to England, we think it nothing but just that it should be known where it originated. In order to show up the principle in its best light so that any one may see it, I send you a woodcut for illustration in your paper. The prints from this cut are so sensitive in a good light that it is impossible to be still enough or to hold the card still enough to prevent the vibrations from being seen—a very sensitive instrument indeed; even the woodcut, as you will see, is equally sensitive, although it has been inked and is all one color (black). Please do me the justice to insert this cut, with whatever remarks you may think appropriate, and very much oblige one of your old patrons.

PROF. P. HAYDEN.

90 Diamond St., Pittsburg, Pa.,
October, 1879.

[We presume that Prof. Thompson was unaware of the prior discovery of this curious phenomenon by Prof. Hayden, or he would have given due credit therefor.—EDS. S. A.]

THE DYNAMIC BAROMETER.

M. A. WINKLER, of Odessa, describes, in *La Nature*, an apparatus for which he proposes the name of "dynamic barometer," since it indicates the pressure of air in motion, while the ordinary barometers show the pressure of the air at rest. The following is a description of his invention:

The body of the vane (Fig 1) is formed of a hollow tin or brass cylinder, A, into which, on the windward side, enters a conical tube, B, having its exterior orifice protected from the rain by a screen, D. On the side opposite to the cone there is fixed in the cylinder a cylindrical tube, C. The spindle, E, of the vane is hollow, and communicates freely with the interior of the cylinder, A, as well as, at its lower end, with a barometer, which is placed within reach of the observer. The letters, F, indicate the wings of the vane, and the letters, G, elastic stuffing-boxes serving to hermetically close the reservoir, A, while still allowing the vane to work freely.

It is clear that the wind on entering the cone, B, and passing from thence into the cylindrical tube, C, tends to exhaust the air contained in the reservoir, A, and this exhaustion produces a depression which is at once shown by the falling of the barometer. This depression is very definitely related to the wind's velocity, so, then, by comparing the readings of the ordinary, or static, barometer with those of

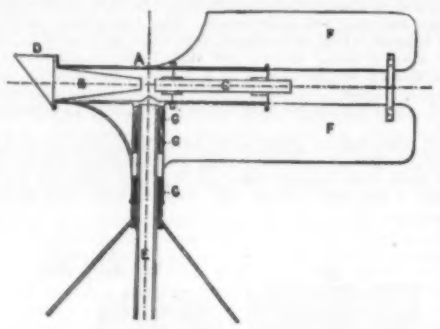
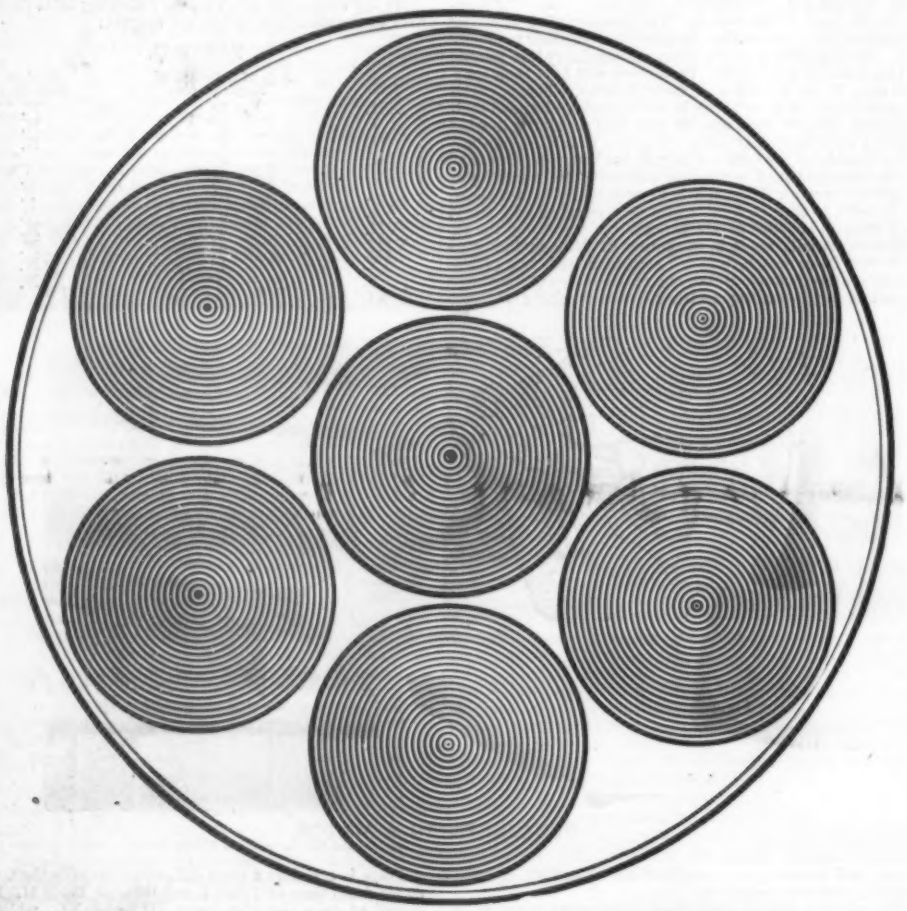


Fig. 1.

the dynamic barometer, we deduce, from the differences of height between the two, the velocity of the current (precisely as for every liquid body) according to the formula:

$$\frac{W^2}{2g} = \frac{p_1 p_2}{7}$$



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The difference of the barometric heights, $p_1 - p_2$, must be expressed in kilogrammes per square meter. The mean weight of the air (the weight of a cubic meter) must be deduced for

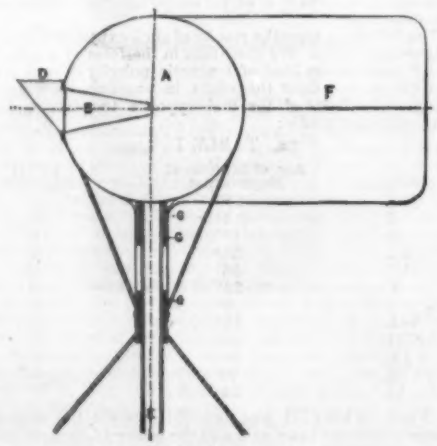


Fig. 2.

each particular case of barometric pressure of the air, as well as of its temperature; but for approximate calculations, it might be sufficient to assume the mean value which is generally adopted—1·29 kilogrammes—and in this way every person of intelligence, by taking the difference between the barometers, could obtain, with more or less accuracy, an idea of the active force of the wind and consequently of its velocity. It should be remarked, however, that since the apparatus is not perfectly sensitive, owing to the fact that more or less of the active force of the wind is lost through friction and resistances of various natures, the true velocity is deduced from the formula:

$$\frac{W^2}{2g} = (1+\zeta)\frac{p_1 - p_2}{7}$$

where the coefficient, ζ, indicates the quantity that must be added to the difference of the observed barometric heights, in order to compensate for the loss of active force. This coefficient must be specially determined for each apparatus by experiment after it has been set up. By knowing the velocity of the wind, its pressure might also be calculated; but it would be more convenient to have special indications of pressure, and for this purpose to erect another apparatus, such as seen in Fig 2, and which is but a modification of the former. Instead of the cylinder, A, it consists of a hollow sphere, A, into which is inserted, on the windward side, a conical tube, B. The cylindrical tube, C, of the first apparatus is done away with, and the wind blowing into the sphere creates therein a pressure which varies according to the velocity. This pressure is then transmitted through the hollow support, E, to a gauge located in the observer's study. If the pressure-gauge consists, for example, of an open siphon, and if the difference of level in the two arms of the latter is 100 millimeters of water, this means that the pressure of the wind is 100 kilogrammes per square meter above the atmospheric pressure, since that is the height of water necessary to balance such pressure. These indications may be registered in the same way as those furnished by the barometer, and in order to have an exact idea of the weather, the meteorological bulletins of a locality would have to publish, instead of a single barometric curve, three curves, one of which (the upper) would indicate wind pressures, the middle one would correspond with the static and the lower with the dynamic barometer. In case of calm these three curves would be united in one. Again, by indicating the direction of the wind by means of arrows arranged at equal intervals of time in the lower curve, we would have a very complete graphic representation of the state of the atmosphere of a locality.

NEW RESEARCHES ON THE THEORY OF THE MICROPHONE.

By Dr. JULIAN OCHOSWICZ.

Two distinct hypotheses have been put forward to explain the phenomena which occur in the ingenious discovery of Mr. Hughes. The one, exclusively molecular, supposes dilatations and contractions of the molecules in certain partially conducting bodies, to take place under the influence of sonorous vibrations, in the microphone itself. *Changes of density* correspond to the increase or decrease of the resistance of the circuit, and, consequently, to a proportional production of sounds. This hypothesis bears a certain analogy to the phenomena which take place in selenium under the influence of light and radiant heat.

The other, partly molecular and partly mechanical, rests upon the discovery, made some time ago, by M. Du Moncel, and according to which the increase and decrease of resistance are due to changes of pressure in the electrical points of contact. These changes being produced by the pressure of the vibrating air, there results an equivalence of causes and effects.

In basing my theories on experiments made with a very great number of microphones, since the first appearance of this discovery, I shall endeavor to prove that, if one of these hypotheses is entirely erroneous, the other is only superficially true.

In the first place:

1. When the carbon rod is immovably fixed by any cement, wax, for example, without submitting it to any pressure, the microphone remains inert under the most powerful sonorous effects. This would be impossible if it acted by molecular action only and not mechanical.

2. The microphone can be placed in a tube of glass, lightly suspended by means of a fine wire, and the air exhausted in the tube, without effecting its microphonic effects. It is evident that, in this case, the waves of air can have no influence upon the density of the carbon: they only act mechanically by shaking the whole apparatus.

3. It is impossible to construct a microphone of a single piece of solid carbon, presenting firm contacts, which do not prevent molecular influences, but which render impossible the action of sonorous waves, of contacts, and of shakes, on the current which traverses the carbon.

It appears to me, then, that we have these sufficient reasons for entirely rejecting the exclusive molecular theory.

Again:

1. The lateral pressure exercised on a compact electric conductor (metal, carbon, etc.), placed in a telephone, does not produce any microphonic action.

2. A longitudinal pressure exercised on the rod of a microphone by means of a thumb-screw, can modify within certain limits without altering the action of the apparatus. This is only the *timbre* which alters the intonation. But the same effect can be obtained without change of pressure, by the simple fact of changing the points of contact. If the pressure is augmented, the apparatus loses its sensibility at the same time that it loses its faculty of vibrating mechanically; but the single fact of an augmentation of pressure has no connection with any microphonic phenomenon. This experiment relates to a microphone with a membrane.

3. Apparatus can be constructed in which the pressure remains the same, and which nevertheless acts as a microphone. (See Figure.) It is hardly rational, therefore, to consider pressure as the essential cause of microphonic phenomena.

It is, however, an accidental cause, for when the sonorous waves strike the movable part of the apparatus, the pressure which it exercises on the support changes; but this is not from the fact of the pressure causing the differences of resistance; it is from another fact, often parallel to the first, but which differs from it.

In order to understand this better, let us consider the apparatus in its simplest form, as shown by Fig. 1.

Two short pieces of wire, in circuit with the microphone and telephone, are stretched across one another as shown; the current passes at the point of crossing. It is *at this point only* that the microphonic action takes place. When one of the wires is caused to vibrate from any cause, a noise or very strong musical sound fills the room in which the

telephone is placed. If the wires are good conductors the action of the apparatus has two phases: the current passes when one wire touches the other; it does not pass when the reverse is the case. There is then a *simple and complete interruption of the current*, and, in consequence, this microphone, like the transmitter of Reiss, like the singer of Mr. Pollard, etc., can only transmit simple sounds. This first category embraces all the microphones in which the contact

FIG. 1.

is effected at a single point. I have obtained better results of the kind with a bladder membrane and sharp point. The electric communication was insured by a little strip of tin foil glued on the membrane. With a small bichromate battery the tune could be heard all over a room. Strictly speaking, there is in these simple apparatus certain graduations of action between the limits of full intensity and of complete rupture of the current, and one can understand that sometimes the *interruption is only partial. It is then the alteration of the points of contact* which plays here the principal *rôle*. The *intensity* of the sounds depends upon the greater or less number of these points; the number of successive interruptions of the same contacts determines their *pitch*, and the nature of the changes their *quality*. In fact, the successive and simultaneous combinations, periodic or non-periodic, of all these changes determine their *articulation*. It is sufficient to compare the traces of the words in the phonautograph, the logograph, and the phonograph, to convince one's self that it is, in these apparatus, only a reduction of *quality* to quantity. I am even inclined to believe that this reduction is very simple, and that a series of combinations in times and in spaces of *three material points of contact* is sufficient to produce an equivalent to all our articulate sounds. It would be difficult to relate all the experiments and inferences which have led me to this supposition, but I give them for what they are worth, and now pass to the third category.

The principle of the change in the number of points of contact caused by pressure allows us to consider the different resistances of the microphonic circuit, and explains the action of the majority of microphones, but it does not explain all.

It is possible to construct, in fact, microphones in which no alteration of pressure will produce a variation in the numbers of points of contact, but which, nevertheless, work well.

Suppose a little cylinder of carbon, *a* (Fig. 2), fixed horizontally to a membrane, M M, and sliding on another small cylinder of carbon, *b*, movable about its axis. If the cylindrical form of these two pieces is perfect, the pressure and the number of points of contact remain the same. If this is not so, as would practically be the case, then the *rôle* played is different; it is *the* length of the route traversed by the current in the bad conductor. While the membrane vibrates, its distance from the carbon, *b*, diminishes or increases, and there is then a change in the number of the points of resistance crossed.

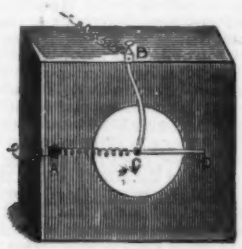
FIG. 2.

It is this class of apparatus to which belong the liquid telephone transmitters of Gray, Bell, and Palet, where the change of resistance in the circuit results from a layer of liquid more or less thick, which is to be traversed by the current.

It is very difficult to separate the two principles one from the other, but it is possible to determine the preponderance of the one or the other, or still better their parallelism. Suppose, for example, that the two cylinders of carbon, *a* and *b*, were replaced by two plates of the same material, and that *b* remains immovable, the two actions would be equal and opposite. The same complication presents itself in the microphonic transmitter of M. Righi, where the metallic disk of the membrane plunges in the powder of plumbago mixed with powdered silver.—*La Lumière Electrique.*

A MUSICAL MICROPHONE.

IN attempting to transmit musical sounds by the microphone, it is usually found that the sound emitted by the telephone has degenerated to a hoarse rattle, caused by the jarring of the movable part of the microphone. By reducing the play of the lever, or upright piece, this disagreeable effect may be diminished, but only at the expense of the sensibility of the instrument, which is then mute to the higher and softer notes.



The form of microphone described below is free from these objections, and, so far as I can tell, it transmits every musical sound, high or low, absolutely pure and unchanged. It may, therefore, be found useful for the accurate study of the sounds emitted by the diaphragm of the telephone. It consists of a deal box of a cubical form, about a foot high. It is open at the back, and has a circular aperture in the front. A piece of gutta percha tissue is tightly strained over a wooden ring and fixed upon the aperture. In the center of this diaphragm a small block of carbon is fixed, connected by a fine wire with the binding screw at A. At B is another binding screw, and from it proceeds a light steel spring tipped with carbon, and bearing with very gentle pressure upon the carbon block at C. The pressure of the spring can be regulated by any suitable means. Perhaps the simplest way is to take a stiff brass wire, bend it at right angles, and pass one end through a hole in the box at D, in which it slides stiffly. Its other end can then be made to bear with any required pressure upon the end of the steel spring.—*W. H. Snell, in Eng. Mechanic.*

ARBORESCENT ELECTRIC DISCHARGES.

IN former numbers of the *Telegraphie Journal* we have illustrated the interesting experiments of M. Gaston Planté on the form of the sparks obtained from his rheostatic machine of 80 condensers under various conditions. More of these have recently been published by him in the second part of his work on "Recherches sur l'Électricité," and we are now enabled by his courtesy to place before our readers the most novel of them.

FIG. 1.

ARBORESCENCES.

When the poles of the machine are laid on a plate of insulating matter sprinkled with powder of sulphur the sparks are much elongated, and they also present tree-like figures when the excess of sulphur is raised by slight shocks given to the plate. Fig. 1 shows one of these figures, full size, obtained from a spark 0·15 meter long.

FIG. 2.

These effects explain the patterns of vegetation sometimes seen on persons struck by lightning; they are merely the branching of the lightning track.

Fig. 2 represents the furrow produced in the sulphur by a spark before giving the shocks which cause the arborescences. It will be observed that the width of the furrow is greater on the side of the positive pole. On the rays round the positive pole the sulphur is heaped up, while the traces round the negative pole correspond to the negative features seen in Fig. 1.

LICHTENBERG'S FIGURES.

On a surface of pure resin shed with powder of sulphur and red lead the sparks give beautiful Lichtenberg figures of a different kind, which, when fixed on gummed paper, constitute valuable aids to the study of the electric discharge. These are illustrated by Figs. 3 and 4.

FIG. 3.

The difference between the effect produced by the brush discharge and sparks is very marked.

When the distance between the points of the excitor is too great for the spark to pass, and a brush discharge only appears, the electric movement of the ponderable matter leaving the negative pole, manifested by the red lead which adheres to the resin, does not extend to the positive pole. This last pole only presents traces of red dust in the middle of the crown of sulphur, with diverging rays, which surrounds it (Fig. 3).

But if the spark has passed, this crown is open and the interior is filled with red lead powder, showing that the electric movement leaving the negative pole extends even to the positive pole (Fig. 4).

FIG. 4.

In the case of the spark the distribution of negative electricity presents a curious crab-shaped appearance (owl-shaped would, we think, be a better term); in the case of the brush it resembles more or less the form of a polyp having its tentacles directed toward the positive pole without attaining to it.

On the other hand, when the spark passes one recognizes sometimes, by the traces of sulphur round the negative pole,

that the emission of positive electricity extends itself to that pole. There is a mixture of the two electricities at each pole (Fig. 5).

This observation explains how in the circuit currents of very high tension, which approach closely to a series of continuous static discharges, can produce complete decomposition of water at each pole, and consequently a mixture of oxygen and hydrogen.

FIG. 5.

One remarks also that the movement leaving the positive pole envelops externally, like a sheaf of rockets, the negative movement (Figs. 3, 4, 5).

Often one perceives at the same time an interior flow of positive electricity round the line of the spark, besides the positive exterior enveloping current, and between the two the negative electric current, which seems as if sucked up (*aspirée*) by the positive current (Fig. 6). The negative

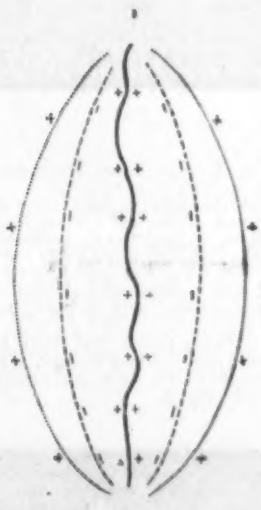


FIG. 6.

electricity of the ponderable matter which she takes along moves in an annular space formed by the electrified matter leaving the positive pole. This observation explains the effects of suction or ascension of water that we have obtained with currents of high tension. Do we not also in this phenomenon find the explanation of the uprise of water in the cloudy interior of a waterspout?

THE POCKET TELEMETER.

ALTHOUGH it is possible to measure the distances of accessible or inaccessible points without the aid of instruments, absolute accuracy is unobtainable by the processes used for this purpose; and hence arises the necessity of some instrument which shall give such measurements correctly and rapidly. The Telemeter invented, and recently improved, by Lieutenant Gaumet, fulfills in the highest degree, through its simplicity, the facility with which it can be used, and its small compass, all the conditions that an instrument of this nature should satisfy. This pocket telemeter is composed of two essential parts:

1. A system of two mirrors, D E (Figs 1 and 2), arranged on a small metallic plate in such a way as to form an angle of 45° between them. One of them, D (Fig. 2), is stationary, and the other, E, is mounted on a movable radial bar. The angles of the mirror may thus be made to vary from 41° to 49°.

2. A very accurate micrometer screw with a half millimeter thread. The head of this screw is a circle divided at its circumference into a hundred parts. The screw itself works in a nut which is fastened to the metallic plate. A small rule is fixed to the edge of the latter, almost in contact with the edge of the circle, and serves as a datum reference. A spring, bearing on the extremity of the radial bar, maintains a permanent contact between the latter and the end of the screw. All these parts are arranged in a rectangular box, having in the back part a horizontal slit to serve as an eye-hole, and in front a rectangular opening for the entrance of the luminous rays emanating from the objects seen by double reflection. A tape line 10 meters in length, rolled around a bobbin, is affixed to the instrument and is used for measuring bases. The pocket telemeter is a direct application of the principle of double reflection. "When a luminous ray is reflected by two plane mirrors in succession in a plane perpendicular to their intersection, the angle formed by the incident and reflected rays is double the angle of the mirrors."

In measuring a distance with the pocket telemeter there are three operations to be performed:

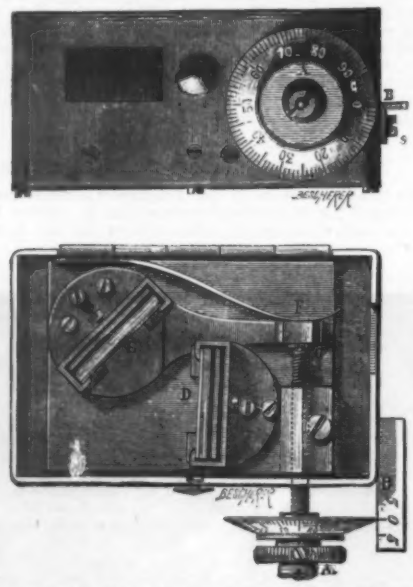
1. The determination of a right angle, or one that is nearly so, C A M (Fig. 3).

2. The measurement of a base line, A B, by means of the tape, or by pacing.

3. The measurement of the angle at the summit, A C B.

The telemeter furnishes the means of constructing the angle, C A M, and of measuring the angle, A C B.

An observer desiring to measure the distance, A C (Fig.



FIGS. 1 AND 2.—GAUMET'S POCKET TELEMETER. Perspective View, and Horizontal Projection, Actual Size.

3), places himself at A in such a way as to see at his right the point, C. The image of the point, C, appears placed directly beneath a natural or artificial signal, M, seen directly and situated on the direction perpendicular (or almost so) to A C. The angle, C A M, is a right angle every time that the two mirrors form an angle of 45°. When there happens to be no natural signal on the perpendicular direction, and it is impossible to locate an artificial one (man or rod) thereon, a neighboring point is chosen for this purpose; and, upon this point is brought the image, C', of the point, C, by turning the mirror at a small angle by means of the milled head of the screw.

(The error resulting from obliquity of the base is less than 1-200th of the distance when the inclination of the former does not exceed 8°.)

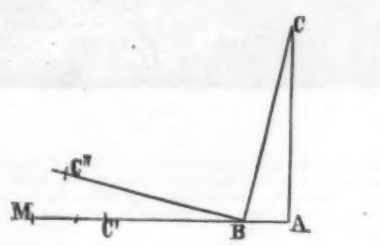


FIG. 3.

The image of the point, C, appearing in the direction of the point chosen, the observer measures off a base, A B, of 20 meters in the direction, A M. He then proceeds to the extreme end of the base and regards the signal anew. He then finds that the image of the point, C, no longer coincides with the signal, M, but is deflected to the right at a point, C"—C' B M being equal to A C B. In order to make them coincide again the movable mirror has to be turned at an angle equal to half of C' B M, or of A C B, which is equal to it. In the pocket telemeter, the angle of rotation of the mirror is measured by its tangent, and this measure is effected by means of the micrometer screw. The use of a like process gives a very close approximation; in fact, by means of the micrometer screw, a tangential displacement of 1-600th

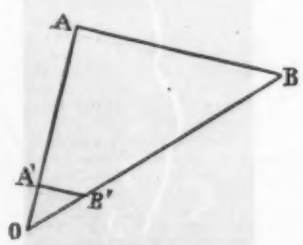


FIG. 4.

of a millimeter may be measured. When a coincidence between the signal and the point, C, has been effected at the end of the base line, the number of the division facing the side rule is read upon the head of the screw. The total number of divisions gives the measure of the tangent of the mirror's angle of rotation. This angle is half the angle, A C B, and the latter being always very small, the tangent of the angle, A C B, may be allowed, without perceptible error, to be double the tangent which measures the angle of rotation of the mirror.

Finally, for the purpose of doing away with all calculation, a table fixed to the under side of the instrument, and protected by a sheet of transparent horn, at once gives the distance which corresponds with each number of divisions. This table has been constructed on the supposition of a base of 20 meters. To measure greater distances, a base of 40 up to 4,000 meters may be taken, one of 60 up to 6,000 meters, etc.; in such cases, the numbers given in the table are doubled, tripled, etc.

The average time consumed in a telemetric operation is about two minutes, and it can often be performed in less than one minute.

The use of this instrument in the measurement of distances is limited only by the visibility of objects, and it has been employed to estimate distances of 6, 8, and 10 miles when the points regarded have been sufficiently visible against the horizon.

The telemeter may likewise be used for measuring the distance of two inaccessible points, A B (Fig. 4). In this case, the distances from the station point to the points, A B, are measured with the instrument, and then on the directions, O A and O B, are taken the lengths, O A', O B', proportional to the distances, O A, O B. The measurement of A' B' by a simple rule of proportion will give the value of A B. From all this it may be seen how great a benefit may be derived from the use of the telemeter in the work of making rapid surveys.

By the use of two instruments in conjunction, on a ship at rest or in motion, the distance from her sides to a point on shore may also be determined. Owing to the construction of the two mirrors they form an angle of 45°, and the images of the doubly reflected objects are deflected 90° when the zero of the micrometer screw corresponds with the zero of the side scale. The instrument, then, may also be used for erecting perpendiculars, and has the advantage over the theodolite in that it requires none of those supports that are always so troublesome to carry, that it can be used with more facility, and that it possesses as great accuracy. The various purposes to which this useful little apparatus may be applied are so obvious that it is scarcely necessary to designate them.

IS TYPHOID FEVER CONTAGIOUS?

By T. J. MACLAGAN, M.D.

TYPHOID fever is one of the most common of the serious ailments of civilized life. No household is safe against it; there is no family which it may not invade. In Great Britain alone not much short of 200,000 people suffer from it every year. Of these nearly 20,000 die, most of them in the prime of life. It is even more prevalent on the Continent.

The question of the contagiousness of such a disease is one of vital importance; and yet it is one on which the most antagonistic opinions are held.

Among the many ailments which may be transmitted from the sick to the healthy, the ones with which we are most familiar in this country are those which are grouped together under the name of "the eruptive fevers." To this group typhoid fever belongs. It includes also small-pox, typhus fever, scarlet fever, and measles. Each consists of an attack of fever of more or less definite duration, and of a local inflammation or eruption; during the course of each its poison is largely reproduced in the system; and each may be transmitted from the sick to the healthy.

There are several ways in which a disease may be transmitted.

1. Its poison may be introduced directly by inoculation, as is daily done in the case of vaccination.

2. It may pass directly into the surrounding atmosphere from the persons of the sick, and be inhaled by those in their neighborhood, as constantly happens in small-pox, typhus fever, measles, and scarlet fever.

3. It may be conveyed indirectly, and to a distance, in articles of clothing, bed linen, etc., and passing from them, may be inhaled by those who wear or handle them, as often happens in the same diseases. Or it may be conveyed in food or water, and enter the system through the digestive organs, as frequently happens with the poison of typhoid fever.

When we wish to say that a disease is transmitted from person to person without defining the mode of transmission, we say that it is *communicable*. The term is a general one, which includes every mode of transmission.

When we wish to say that a disease may be transmitted by inoculation, we say that it is *inoculable*.

When we wish to say that the poison may be conveyed in articles of clothing, in linen, in food, in water, etc., we say that these articles have been infected by the poison, and that the disease is *infectious*.

When we wish to say that a disease is produced by personal contact with one suffering from it, and that the danger of catching it increases with the closeness and intimacy of such contact, we call it *contagious*.

A contagious disease, therefore, is one in which the danger of contracting it increases as we approach and diminishes as we recede from a person suffering from it. It is *contactuous*.

Contagion may be defined as direct infection; and infection as indirect contagion. In both a poison passes from the sick to the healthy. It is the difference in the mode of conveyance of the poison that makes the difference between the two. The distinction is one of the utmost practical importance, and must be borne in mind in discussing the question of the contagiousness of any disease. An ailment may be infectious without being contagious.

In science, precision of language is of as much importance as accurate observation. It is the want of this precision which has led to the diversity, nay the antagonism, of opinion which prevails among the highest authorities on the question of the contagiousness of typhoid fever. M. Piedvache, the chief continental advocate of that doctrine, uses the word contagious as if it were synonymous with communicable: "J'emploierai le mot contagion dans sa signification la plus étendue, designant sous ce nom toute transmission de la maladie d'un individu malade à un individu sain, quelque soit la mode suivant laquelle elle s'opère." Dr. Budd, its great English advocate, uses the word in exactly the same sense, and gives as instances of the contagiousness of the disease, cases in which the second sufferer had never even been in the same house as the first. This is an inaccurate use of the word: from a scientific point of view, the severest judgment that could be pronounced against it. But it is also inaccurate and misleading from a popular and colloquial stand-point. When, with reference to a case of typhoid fever in his own house, a man asks the question, "Is it contagious?" he does not wish to know whether or not some one in the next street may take the disease, but whether or not there is a likelihood of its spreading among the members of his own household, and whether

or not there is danger in going near the sufferer. The only accurate and proper meaning of the word is that attached to it in the definition which I have given. That, therefore, is the sense in which it is used in this paper.

What is the nature of the poisons which pass from the sick to the healthy? Their most distinctive peculiarity is that they are largely reproduced in the system during the course of the maladies to which they give rise. The minutest possible portion of small-pox matter, for instance, may be introduced into the system of a person who has not had that disease, and who has not been vaccinated, with the certainty of giving rise to a malady during whose course there will be formed many thousand times as much of the poison as sufficed to set the disease agoing. All that is introduced may be just so much small-pox matter as adheres to the point of a needle dipped into it. The resulting disease may be characterized by an eruption of thousands of pustules, each containing many times as much of the poison as rested on the needle point. So it is with all diseases which spread from the sick to the healthy; during their course the poisons which give rise to them are largely reproduced in the system. In connection with no ordinary poisonous or medicinal agency is the same thing noted. Many of these are eliminated from the system in the same form in which they enter it; but in not one does the quantity eliminated exceed that received.

This power of reproduction is peculiar to and distinctive of organized structures, animal and vegetable. There is no physical or chemical process at all identical with it. There is nothing in nature identical with it, except that power of reproducing their kind with which all living organisms are endowed. The poisons reproduced during the diseases with which we are now dealing, are also true to their kind, another distinctive feature of organized structures. As surely as an acorn produces only an oak, and a rose seed only a rose tree; as surely as every animal produces an offspring identical with itself; so surely does typhus give rise only to typhus, measles only to measles, and every other allied disease only to its own special poison and malady.

This power of development, and this faculty of breeding true, show that the poisons of these diseases consist of minute organisms or germs. There is no other adequate explanation of these phenomena; and it is now very generally admitted that such is their real nature.

This view serves also to explain phenomena noted in connection with admittedly contagious diseases, which are quite inexplicable on the old and still popular view that the poison consists of a gaseous or vapory emanation. Germs are minute solid particles. It has been proved by M. Chauveau and Dr. Burdon-Sanderson that the poisons of cow-pox and sheep-pox (the analogues in these animals of small-pox in man) consist of such particles. From the fact that the microscope fails to detect these particles in fluids known to contain them, we infer that they are less than $\frac{1}{50000}$th of an inch in diameter, that being about the ordinary limit of human vision. That the atmosphere habitually contains particles so minute that the highest powers of the microscope fail to demonstrate their existence, has been proved by Professor Tyndall.*

Contagion, then, consists physically of minute solid particles. The process of contagion consists in the passage of these from the bodies of the sick into the surrounding atmosphere, and in the inhalation of one or more of them by those in the immediate neighborhood. If contagion were a gaseous or vapory emanation, it would be equally diffused through the sick room, and all who entered it would, if susceptible, suffer alike and inevitably. But such is not the case; for many people are exposed for weeks and months without suffering. Of two persons situated in exactly the same circumstances, and exposed in exactly the same degree to a given contagion, one may suffer and the other escape. The explanation of this is that the little particles of contagion are irregularly scattered about in the atmosphere, so that the inhalation of one or more of them is purely a matter of chance, such chance bearing a direct relation to the number of particles which exist in a given cubic space. Suppose that a hundred germs are floating about in a room containing two thousand cubic feet of air. There is one germ for every twenty cubic feet. Naturally the germs will be most numerous in the immediate neighborhood of their source, the person of the sufferer; but, excepting this one place, they may be pretty equally distributed through the room, or they may be very unequally distributed. A draught across the bed may carry them now to one side, now to the other. The mass of them may be near the ceiling or near the floor. In a given twenty cubic feet there may be a dozen germs or there may be none at all. One who enters the room may inhale a germ before he has been in it ten minutes, or he may remain there for an hour without doing so. Double the number of germs and you double the danger. Diminish the size of the room by one-half and you do the same. Keep the windows shut and you keep the germs in; open them and they pass out with the changing air. Hence the importance of free ventilation, and hence one reason why fever should be treated, if possible, in large airy rooms. Not only is free ventilation good for the sufferer, but it diminishes the risk to the attendants.

We see in this, too, the reason for banishing bed curtains, carpets, and all unnecessary furniture from the sick room in cases of contagious fever. The germs are apt to adhere to such articles, and so make them the means of conveying the disease to others.

The explanation of the varying extent to which those who are equally susceptible and equally exposed, suffer from the action of these poisons, is the same as that which applies to a regiment in action. If the contagion were as diffusible as the gases formed in the explosion of the powder, all those exposed to it would soon be placed *hors de combat*. But just as in battle it is not the explosion of the powder but the bullet which is impelled that is deadly to the soldier, so in contagious fevers, it is not the vapory emanations from the lungs and skin of the sufferer which are deadly to those around, but the contagious particles which are given off with them. And just as some soldiers are killed in their first battle, while others go through many campaigns without receiving a scratch, so some persons take typhus or scarlet fever after a single exposure, while others may be exposed for months before they suffer, and may even escape altogether.†

* Transactions of the Royal Society, Part I., 1876.

† The view that germs play an important part in the production of diseased processes, and especially in the production of those which are the cause of so much fatality after surgical operations, led Mr. Lister to adopt the method of treatment with which his name is associated. This antiseptic treatment, as it is called, simply consists in so performing operations, and in so dressing wounds, that it is impossible for germs to get into them. The simple precaution of excluding the germs which are constantly floating about in the atmosphere, and which Mr. Lister's keen insight and scientific mind led him to regard as the cause of those disastrous consequences which made surgical operations so fatal—this simple precaution has led to one of the greatest advances in modern surgery, and to the saving of many a life which would otherwise have been sacrificed.

All organisms consume in their growth nitrogen and water. Those with which we are now dealing are no exception to the rule. Growing in the system they must get these elements there. But nitrogen and water are the chief materials required for the nutrition and repair of the various organs and tissues of the body. The propagation in it of millions of organisms having wants identical in the main with those of its own tissues must cause serious disturbance. And so it does. This disturbance declares itself by that aggregate of phenomena to which we apply the term fever.

An organism which thus grows in and at the expense of another is a parasite. One of the peculiarities of parasites is that they flourish not in any part of their host, but only in some particular organ or tissue which is called the *nidus* or nest of the parasite. Each has its own special nidus. This one grows in small intestine, that in large; this in skin, that in mucous membrane; this in liver, that in kidney; this in brain, that in muscle. The organisms with which we are now dealing (the poisons of the eruptive fevers) show similar peculiarities. Each has its own nidus, its own localized habitat in which it is propagated, and out of which it ceases to be reproduced. The poison of small-pox has its nidus in the deep layer of the skin; hence its characteristic eruption. That of scarlet fever in the superficial layer of the skin and in the throat; hence the rash and the sore throat of that disease. That of measles in the skin, and in the mucous membrane of the air passages; hence its characteristic symptoms. That of typhoid fever in the glands of the intestine; hence that disease consists of fever and of ulceration of the bowel.*

The contagiousness of a given eruptive fever must be directly as the number of germs which, in a given time, pass from the body of a sufferer into the surrounding atmosphere. This in its turn must depend on the seat of the propagation of the poison, and on the relation which this bears to that atmosphere. In small-pox, scarlet fever, typhus fever, and measles, the seat of this propagation is the skin and mucous membrane of the air passages; it is, therefore, in direct, free, and constant communication with the external air. The poisons of these diseases are accordingly freely given off into the atmosphere of the room in which the sufferer is, and they themselves are highly contagious.

In typhoid fever the poison is propagated in the bowel, and is thrown off with the discharges from it. It thus passes from the system in a manner and in a combination which insure its speedy removal from the neighborhood of the sufferer. The typhoid germs are there, but they are mingled with discharges which may be removed, and as matter of course are removed before the germs can pass off from them into the surrounding atmosphere. The seat of the propagation of the typhoid poison has no direct relation with this atmosphere; germs cannot pass directly from the one to the other; the disease, therefore, does not display the property of contagiousness.

The danger in typhoid fever is not contact with the person of the sufferer, but contact with his stools. If these are properly managed and disposed of the disease can scarcely spread. But if they are allowed to pass into drains which are imperfectly trapped, inadequately ventilated, or insufficiently flushed; or if they are carelessly thrown on the ground or allowed to percolate through the soil into drinking water, then one case of typhoid fever may give rise to many others. The occurrence of a case of typhoid fever in a house is a sharp test of the efficiency of its sanitary arrangements. If these are perfect and the stools properly managed all will go well; if they are defective one case may give rise to many others. But the communication of the disease is not direct by contact; it is indirect by infection of drinking water, or of an atmosphere which may be remote from the person who is the source of the poison. A case of typhoid fever is introduced into a locality. The stools are thrown out on the ground or into a cesspool, whence they percolate through the soil into a well. The person who drinks water from that well runs a greater risk than one who sleeps in the same room as the sufferer, and is in constant attendance on him.

The practical outcome of all this is: 1, that the mother may nurse her son, the wife her husband, the sister her brother, without the risk involved in the case of typhus or scarlet fever; and 2, that there is little or no danger to the other inmates of the house if its sanitary arrangements are perfect and the stools properly managed.

On this view of the nature and mode of action of contagion, it is easy to see not only how the process of contagion and its varying phenomena may be explained, but how, by care, much may be done both to prevent the poison from passing into the atmosphere, and to diminish its chance of acting after it has got there. We have only to consider what is the chief channel by which the contagion gets exit from the system to know by what means we are most likely to prevent it passing into the surrounding atmosphere. In typhoid fever the poison passes off in the stools; and what we have to do is to see that these are promptly and properly disinfected and disposed of. In small-pox, scarlet fever, typhus fever, and measles, it is eliminated by the skin, and we cannot altogether prevent its getting into the atmosphere; but by frequent sponging with some disinfecting fluid, or even with plain water, many germs may be arrested in their outward course.

The apostolic mode of anointing with oil is also an efficacious way of fixing and arresting the germs: it is specially useful during convalescence from scarlet fever in fixing the particles of peeling skin which are a source of much danger. They are dangerous because they contain the germs which have been produced in them. What we see happen in the larger particles of skin happens also in many of the much smaller particles of contagion.

By the adoption of these various measures, by rigorously isolating the sufferer, and by having the room well ventilated, much, very much may be done to check the spread of contagious fevers. The matter of which organisms are composed is one of the most perishable things in nature. Contagion is no exception to the rule. By exposure to the air much of it is destroyed; hence such exposure is one of the best of all disinfectants. For one germ that comes to maturity thousands perish. It is the same throughout nature; for one acorn that produces an oak, for one rose seed that develops into a rose tree, for one ovum that develops into an animal, many thousands die. In her arrangements for insuring the continuance of a species, Nature is almost wantonly lavish. In her arrangements for keeping its numbers within proper bounds she is equally provident.

Sanitary science has done much to show us how some of the diseases with which we are now dealing might be extinguished, and how all of them might have their prevalence greatly diminished. It rests with those who have such ailments in their houses to carry into effect the measures calculated to destroy and get rid of the poison before it has had time or opportunity to be a source of danger to those around. But the adoption of proper measures presupposes a knowledge of the nature of the poison with which we have to deal and of the manner in which it passes off from the system. In not one is this knowledge more necessary than in typhoid fever; in not one are the measures which such knowledge dictates more easily applied, or more likely to be effective. But to regard typhoid fever as contagious in the sense that small-pox and typhus fever are so is to divert attention from the true source of danger; to lead to the adoption of measures which are uncalled for to the neglect of those which are urgently required, is to cause unnecessary concern to the sufferer and his friends, and to deprive him and them of the mutual comfort and solace which a little daily intercourse affords. The peculiarities of the illness may be such as to make it right to exclude the friends, but isolation is not requisite for the same reason that it is so in typhus.

One more point. The receiver as well as the giver of the poison has something to do with the determination of its action. Not every person into whose system a germ passes necessarily suffers from its action. A man who has had small-pox, for instance, is no longer susceptible to the action of its poison—and why? Not because the poison cannot get into his system, for we can make sure of that by inoculating him with it; but because, during the first attack, the nidus, the special material necessary to its propagation, was exhausted, and has not been reproduced. This immunity from a second attack is a general characteristic of the eruptive fevers; individual exceptions there are, but the rule is that one attack confers immunity from a second.

A germ does not act unless it reaches its nidus; it may enter the system, make the round of the circulation, and again pass out without ever coming in contact with its nidus, and therefore without doing harm. The more widely the nidus is diffused, the less likely is this to happen. In small-pox, in scarlet fever, and in measles, the nidus is widely scattered. In none of them is a germ likely to make the round of circulation more than two or three times without being conveyed to its nidus.

In typhoid fever the nidus is situated in a limited portion of the bowel, the sole route to which by way of the circulation, is through an artery the size of a crowquill; a typhoid germ may be taken in through the lungs, and may make the round of circulation two or three dozen times, without being likely to enter that particular vessel. The more often this may occur the greater the chance of its being thrown off from the system without acting. But if the typhoid germ be taken in through the digestive organs, it is brought into direct contact with the seat of its nidus, and can scarcely fail to act. Hence the great danger of drinking water or milk contaminated with the typhoid poison. Milk is more dangerous than water under these circumstances, because so much of the water is boiled before it is used, and because the water requires no digestion, but passes directly into the circulation from the stomach, and unless there is food in the stomach may carry the typhoid germs with it into the circulation, where they have the same small chance of reaching their nidus that they have when inhaled through the lungs. Milk, on the other hand, requires digestion, and the germs mingled with it are more likely to be carried down the digestive canal to the seat of their nidus.

The glands which constitute this nidus are not equally prominent and active all through life. In infancy they are quite rudimentary. At two or three they begin to grow and gradually increase in size, and presumably in functional activity till the age of puberty. They continue to be very distinct for twenty or twenty-five years. After forty they begin to get less, and gradually diminish till at seventy they have dwindled away so much that they can no longer exercise any active function. Their period of prominence and of functional activity corresponds exactly to the period of susceptibility to the action of the poison of typhoid fever. That disease is extremely rare in infancy; from two to six or seven it is more common, but is generally very mild. At fifteen or sixteen commences the period of greatest liability to it; and from that age on till thirty-five and forty it is very common and very fatal. After forty-five it begins to decline both in frequency and severity, and goes on declining as years advance till at seventy the liability to it may be regarded as practically worn out. When it occurs in advanced life it is generally mild, but its occurrence then is as rare as in infancy. Increased and diminished susceptibility to the action of the poison of typhoid fever correspond exactly to the increase and diminution in the size and functional activity of the glands which constitute its nidus. A rich nidus means a rich field for the propagation of the poison, and a correspondingly severe attack of the disease. A poor nidus means a poor soil, a scanty growth of germs, and a mild attack.

When the nidus is exhausted the propagation of the germs ceases, and the disease comes to an end. The insusceptibility to the action of the poison which is naturally and slowly developed in old age, is artificially and rapidly produced by the destruction of the nidus during an attack of the disease.

Using the word contagious in its proper sense of communicable by contact, and regarding the typhoid poison as a parasite whose nidus is in the glands of the bowel, we are led to the conclusion that the disease to which it gives rise, though undoubtedly infectious, can scarcely be contagious. We know from our experience that it is not so, for it never spreads in hospitals, and attendants on the sick suffer no more than other people.

The difficulty has been to reconcile these facts with the reproduction of the poison in the system. The source of this difficulty is the rooted belief that this reproduction takes place in the blood. On this view all the eruptive fevers ought to be equally contagious. But let us once adopt the view that the poisons of the eruptive fevers are parasites, and that the seat of the local lesion of each is the nidus of its parasite, and therefore the seat of its propagation, and the whole difficulty vanishes. We at once see why each has a definite period of duration, why one attack protects against a second, why each has its own characteristic lesion, why each presents such varying degrees of severity, and why they possess different degrees of contagiousness.

* It is very generally supposed that the eruptions of small-pox, measles, scarlet fever, and typhus fever, as well as the bowel lesion of typhoid fever, result from nature's efforts to eliminate the poisons of these diseases from the system. Did nature possess the wisdom and the power to make such an effort, she would better exemplify her wisdom, and more efficiently use her power by bringing the latter into operation at an early period of the illness when the poison exists in small quantity, and when it might be got rid of not only more easily, but before it had so increased as to imperil the safety of its victim. These lesions are really the result of the action which, in each of these fevers, takes place during the propagation in its nidus of the organism which causes the disease. The passage outwards of the germs is in each case the physical and inevitable result of the situation of the lesion.

There is not one of the phenomena of the eruptive fevers which is not adequately explained on this theory. There can be no stronger argument in favor of any theory than that it is competent to explain all the phenomena which it is intended to elucidate.*—*Nineteenth Century.*

IRON IN THE BLOOD.

AMONG the various constituents of the animal body, especially of the blood, iron is one of the most important, and many forms of disease are traceable directly to a deficiency of this element. In such cases a natural treatment would be to supply a medicine containing iron in some assimilable form. Unfortunately, many constitutions do not take up this iron, and languish in its absence. The usual form in which iron occurs in the blood is as a neutral solution of the peroxide of iron; and of late, considerable attention has been given in pharmacy to the manufacture of preparations that shall correspond, as nearly as possible, with it.

That which seems most thoroughly to solve the problem is what is now known as dyalized iron, and which, as manufactured by Brarèt, of Paris, has attained a very high reputation. Unfortunately, by the ordinary method, the process is extremely slow, and the cost of the preparation is so great as to be beyond the reach of any but wealthy patients; and the French preparation, with its original high price and its corresponding diminution in importation, is but little known in the United States.

Quite recently, Messrs. Wyeth and Brother, of the United States, have devised some new applications in the way of dyalizers, by which the yield is greatly increased. The other concurrent advantage of dyalized iron in pharmacy, besides its resemblance to the natural condition of the blood, is in the absence of any styptic or other unpleasant effect, as in not destroying the teeth or producing any inconvenience. Dyalized iron, as prepared by pharmacists, has another advantage over some of the preparations of iron, in being permanent and not changing with time.

In this connection it admits of one important application; namely, as an antidote to arsenic. It is well known that the only sure preventive of arsenical poison consists in the speedy administration of hydrated sesquioxide of iron. This, however, to be serviceable, must be freshly prepared, as if long prepared it is of no value; and as its manufacture is somewhat tedious, the patient may die before the remedy can be applied. In the possession of the dyalized iron, it is claimed that the apothecary will always have at his command the means of preventing death from the internal administration of arsenic.

DIABETES MELLITUS.

By J. H. SALISBURY, A.M., M.D., Cleveland, Ohio.

DRINKS, FOOD, BATHING, EXERCISE, CLOTHING, AND TREATMENT IN DIABETES MELLITUS.

Drinks.—Drink one-half pint of beef tea, made from pure lean meat fiber, free from tendon, cartilage, and fat, at each meal, and the same amount between two hours after dinner and one hour before supper, and between two hours after supper and one hour before breakfast the next morning—making in all three pints of beef tea in the twenty-four hours. Take no other drinks of any kind or description, unless it be a few mouthfuls of clear tea or coffee with the medicine. To quench thirst, put into each half pint of beef tea five grains of nitrate of potassa.

Food.—Eat broiled beefsteak which has been entirely freed from fat, tendon, cartilage, and bone, before cooking. Have it seasoned to taste with butter, pepper, and salt. For variety, use the steaks (broiled) which are cut from the center of the round of a lamb or mutton, broiled oysters, broiled fish that are free from fat, broiled quail, broiled woodcock, broiled partridge, broiled grouse, and broiled codfish. The whites of eggs may be taken raw or soft boiled occasionally with the meat. Use butter, pepper, and salt for seasoning. Worcestershire and Halford sauces may be used on the meats if desired. This lean meat diet and the drinks should be rigidly followed out for at least two or three months, or longer if the healthy functions of the liver and kidney are not by that time fully restored and established, so that the diseased conditions do not return by departures from the lean meat diet.

The urine should flow at the rate of three pints daily, and stand at or near a density of 1·020. This state of things should be present continuously for five or six weeks before bread and vegetable food should be ventured upon. When it is thought the right time has arrived, begin by allowing the patient one mouthful of bread at each meal. Take this bread after the meat is eaten. If after a few days the urine continues to remain at 1·020 density, or thereabouts, and flows at the rate of three pints only in twenty-four hours, increase the bread to two mouthfuls at each meal. In this way, advance gradually and cautiously, step by step, till at the end of four or five weeks the patient is taking two parts of lean meat to one of bread, toast, boiled rice, cracked wheat, or potato. Keep up this kind of diet in the above proportions continuously for the following six months, before fruits (except the lemon) are ventured upon. A little lemon juice on the meats, or after meals, may be indulged in at any time during the progress in the cure. After the patient is sufficiently recovered to take, with safety, one part of bread, toast, boiled rice, cracked wheat, or potato, to two of the meat, half a pint of clear tea or coffee may be substituted for the beef tea at each meal. During the entire treatment, all sweets, pies, greens, cakes, vinegar, pickles, sauce, preserves, puddings, soups, crackers, crullers, cheese, milk, mush, cream, fruits, and vegetables should be rigidly avoided.

Baths.—Take a soap and hot water bath twice a week for cleanliness, after which oil all over with sweet oil and glycerine, rubbing in well. Every night or day, sponge all over with hot water, in which put from half to an ounce of aqua ammonia to the quart of water, rub in well and wipe dry afterward. Every day put a teaspoonful of dilute nitro-muriatic acid in six ounces of hot water, and rub in thoroughly over the region of the liver. Keep this up till a miliary eruption appears, then stop it till eruption disappears; then resume it again till eruption again shows itself, and so on during the progress of cure.

Clothing.—Wear flannel or silk next the skin, and dress comfortably warm. On retiring, change all clothing worn during the day, so that it may be thoroughly aired for the following morning. Keep the clothing sweet and clean by changing every other day. The bed should be thrown open on rising, and the bedding well aired during the day, and the bed not made up till it is time to retire.

Exercise.—Ride and walk daily in the open air as much as possible, without fatigue. Four to six hours in the twenty-four should be spent in this way. If not able to walk or ride, the body and limbs should be rubbed and pounded all over for twenty minutes, morning, noon, and night, by some one who has strength to do it thoroughly.

Meals.—The meals should be taken at regular intervals, and it is better not to sit down at a table where others are indulging in all kinds of food. Eat alone or with those only who are on the same kind of diet. After the system gets in good running order, which is indicated by the urine flowing at the rate of from three to four pints daily, and standing at a density of from 1·020 to 1·026, the appetite becomes good, and often ravenous. Frequently, in this state of the cure, more than three meals a day are desired. This desire should be gratified by allowing the patient a nice broiled steak between breakfast and dinner and dinner and supper. These extra meals should be taken at fixed and regular hours every day.

Treatment.—Just before each meal the patient should take a small dose of some good, bracing tonic. As the bowels are almost uniformly constipated in this disease, this medicine should have a laxative tendency, without increasing the activity of the liver. Here the good judgment of the physician will be brought in play. If the system is debilitated and the patient is nervous and wakeful, with considerable emaciation and constipated bowels, something like the following would be appropriate:

℞ Fluid ext. letttuce ..... ℥j.
" " lady's slipper. ..... ℥ij.
" " cinchona comp ..... ℥ij.
" " aromatic ..... ℥j.
" " golden seal ..... ℥j.
" " digitalis ..... ℥j.
" " apple root bark ..... ℥jss.
" " rhubarb ..... ℥jss.
Oil menth. pip ..... gtt. x.
Oil gaultheria ..... gtt. x.

M. S. Take a teaspoonful before each meal.

℞ Salicin ..... ℥j.
S. Take six grains immediately after each meal.

℞ Benson's capcine porous plaster.
S. Apply to back, over kidneys.

If the gases that pass from the bowels are offensive with the sulphide of ammonium and sulphide of hydrogen, indicating decay in the contents of large intestines, give the following:

℞ Carbolic acid (pure white crystal).... ℥j.
Water ..... ℥xvj.
Oil menth. pip ..... gtt. xvj.

M. S. Take a teaspoonful fifteen minutes after each meal.

To assist in increasing the activity of blood glands, and to act as food in making bone, nerve, and muscle, give as follows:

℞ Hypophosphite of iron ..... gr. x.
" " soda ..... ℥ss.
" " potassa ..... ʒj.
" " lime ..... ℥ss.

Mix, and make pills No. xxx.

S. Take a pill after breakfast and dinner.

To sweeten the bowels, correct acidity, to invigorate the entire organism, and to prevent the debilitating influence of the interstitial death and decay of cells and fibers, give as follows:

℞ Spts. ammonia aromatic..... ℥vj.

S. Take a teaspoonful in each half pint of beef tea drunk between meals.

To keep the bowels open, use a pill that acts as a tonic to the entire intestinal tract, without stimulating directly the liver. Something like the following would be appropriate:

℞ Aloes socot..... ʒj.
Gum myrrh..... ʒj.
Piperine..... grs. xxv.
Ext. henbane ..... grs. vj.
Ext. colocynth..... grs. xxv.
Ext. rhubarb ..... grs. xv.
Oil menth. pip ..... gtt. xij.

Mix, and make pills No. xxx.

S. Take part, or a whole pill, or more, if necessary, on retiring.

If there is irritation of the rectum and lower bowel, use as follows:

℞ Carbolic acid (pure white crystal) .. ℥ss.
Butter cocoa, oil sweet almonds, and white wax, aa., q. s. to make suppositories..... No. xviij.

S. Insert one in rectum every night.

General remarks.—Avoid all anodynes and other medicinal agents that tend to get the stomach, bowels, kidneys, and skin out of order. The cure is accomplished by removing the unhealthy alimentation that has culminated in the disease, and in aiding the removal of the pathological states of the deranged organs by the use of such remedial agents as assist in restoring normal healthy action.

By judiciously and persistently following out the foregoing plan of alimentation, treatment, etc., the diseased organs and system generally soon begin to take on a more and more healthy state. The urine contains every succeeding day less and less sugar, its density becomes less and less, the quantity decreases, the color heightens, the appetite improves, the eyes become brighter and brighter, the skin loses gradually its dryness, and becomes more and more soft and oily, and the mucous membranes less and less feverish and dry; the thirst ceases and the entire organism takes on little by little, yet certainly and surely, the actual appearances, states, and conditions of health.

In less than one week's time after this treatment is thoroughly entered upon, the quantity of urine decreases from gallons to about two quarts; the density falls from 1·040 to 1·060 down to 1·026 to 1·034, varying with the advancement and severity of the disease. The thirst usually ceases in about three days, after which the sufferings of the patient are comparatively slight.

The slightest deviation in the patient from the course marked out can be detected by the watchful and expert physician at once. A single mouthful of bread, vegetables, fruit, sauce, sugar, or any fermenting, farinaceous, or saccharine food will elevate the density of the urine many degrees by increasing the sugar in it, and the quantity voided will be much greater. The physician should be able to detect at once any departures of the patient, and call him to strict account. No one need hope to handle this disease successfully without a rigid observance of the foregoing rules and regulation.

Medicines alone will not cure the disease. They are only aids in restoring healthy states after the cause or the unhealthy alimentation is removed. None but careless feeders ever have this disease, unless as in rare instances it may be imperfectly developed by local injuries. As the desires and appetites of the patient have to be entirely ignored, the physician must endeavor to so inspire his patient that his soul and body will be in the good work. Unless he can do this, his patient will stealthily yield to the awful cravings of a diseased appetite, too often, to permit a cure possible. The patient can tear down more in one minute by indulging in the forbidden, than the physician can put up in three days. Hence you see the odds are with the patient in his downward course, unless the physician can inspire him with such a sense of duty and responsibility to himself, that the feeling of doing right, under every and all circumstances, will override the cravings of diseased desires and appetites.

Diseases in organs, which arise from defective or unhealthy alimentation, are the result of confirmed habits in eating too exclusively and continuously food which, in the way and proportion in which it is taken, cannot be well digested; consequently it is unfitted for assimilation. The chemical and vital changes of fermentation, decay, and cryptogamic development set in, resulting in the production of agents debilitating and poisonous to the various vital organs which they reach by being more or less taken up by the gland cells of the digestive apparatus.

These desires are pathological habits in the organ or organs affected, and have been brought on by being continuously compelled to do and to be exposed to labors unfitted for it or them to perform or endure, without becoming more or less overtaxed, enervated, deranged, paralyzed, and changed in function, and eventually in structure.

To produce these states, conditions, and changes, requires time and persistent and continued exposure to the before-mentioned abnormal causes and labors. To cure them, also, requires time and the persistent and continued avoidance of all causes producing them, and the constant and unflinching use of such food and medicinal means as will keep the system constantly and continuously in the most perfect running order. This is indicated by the urine flowing at the rate of about three pints daily, standing at a density of 1·020, clear, no sediment being deposited on cooling, and no sugar, albumen, or other pathological body or condition present; the bowels moving once or twice a day, and at the regular time; no pains or aches; head clear, no dizziness; skin and mucous membranes in good order; mind cheerful, and all the normal functions going on in a healthy manner.

In this disease, the lobules of the liver or that portion of the gland which is connected directly with the blood vessels, and which organizes glycogenic matter or animal sugar, is the part that is directly involved. This portion of the liver is too active, and makes more animal sugar than is required. This excess has to be eliminated, and the kidneys have this additional work to do. Soon they, too, become over active, and little by little become involved *indirectly* in the disease.

To effect a cure, we must cut off all food (as far as possible) that goes to make animal sugar. This includes vegetable food, fruits, animal fats, tendon and connective or glue tissue and cartilage. Also all excess in drinks. This lessens the labor of the diseased parts, and little by little, their excessive activity ceases, and normal states ensue, which, if persisted in for a few months, breaks up the diseased habit; normal conditions are restored and become permanent, and the diseased is cured.—*Virginia Medical Monthly.*

SEPARATION AND DETERMINATION OF MANGANESE.

By PROFESSOR J. VOLHARD.

THE author makes use of a standard solution of potassium permanganate, which he prepares by dissolving 38·5 grammes crystals of permanganate in about 2 liters water in a boiling flask. The solution is poured into a well-stoppered bottle, which holds 10 liters, filled up to the mark with water, and well mixed by shaking. This store is kept in a dark place. To fill the burettes, the author uses a 1-liter washing bottle with a wide mouth covered with black paper. Before filling this vessel out of the stock bottle it is several times washed out with a little of the solution. The value of the permanganate solution is then determined, which is best effected iodometrically. For this purpose there are required a solution of sodium hyposulphite and a starch solution, both of known strength, besides a solution of potassium iodide and one of starch.

The reducing liquid is obtained by dissolving 30·061 grammes pure crystalline sodium hyposulphite along with about 3 grammes ammonium carbonate, and making up to 1,000 c.c.; 1 c.c. of this solution = 2 milligrammes manganese. To prepare the iodine solution, 1·5394 grammes dry iodine in crystals are dissolved in a little water by the aid of 3·5 potassium iodide and made up to 1,000 c.c; 10 c.c. of this solution are reduced by 1 c.c. of the hyposulphite solution. The potassium iodide solution should contain per liter 55 grammes potassium iodide free from iodate. The solution of starch is prepared fresh daily.

About 10 c.c. of potassium solution are placed in a beaker, 4 to 5 c.c. pure hydrochloric acid with 150 to 200 c.c. water are added, and constantly stirring about 20 c.c. of the permanganate solution are added from a Gay-Lussac burette. The beaker is then placed under the Mohr's burette containing the hyposulphite solution, and some of this is added till the brown color of the iodide solution is changed to a faint yellow. Starch solution is now added, and hyposulphite again till the blue color is completely destroyed. In order to determine the small excess of hyposulphite which has been added, solution of iodine is added with a small graduated pipette till the blue color just reappears. The volume of hyposulphite consumed, less one-tenth of the iodine solution used, and divided by the volume of the permanganate solution, gives the factor of the permanganate: 1 c.c. permanganate indicates 2 milligrammes × factor for manganese.

The standard of the hyposulphite solution should be checked from time to time. For this purpose the author uses a liquid prepared by dissolving 5·963 grammes potas-

* Those interested in the question, and desirous of more detailed information regarding it, are referred to a work on the ("Germ Theory of Disease," written by myself, and published by Macmillan & Co., in 1879.

sium dichromate, and making up to 1,000 c.c. Of this solution 1 c.c. gives up to hydriodic acid exactly as much oxygen as the quantity of permanganate, which indicates 2 milligrammes manganese; 20 c.c. of the chromate solution are measured off with a pipette, and let flow into the acidified solution of potassium iodide, proceeding exactly as directed above for standardizing the permanganate. If more than 20 c.c. of the hyposulphite are used for reducing the iodine set free the hyposulphite was impure.

Any other permanganate solution of known strength will serve as well for the titration of manganese, and if a solution is kept in stock for the titration of iron it would be superfluous to prepare another. It must be remembered, however, that only three-fifths of the oxygen in the permanganate indicated by ferrous oxide, oxalic acid, or hydriodic acid comes into play in the oxidation of manganous oxide. The manganese standard may be found by multiplying the iron standard by 0 2946.

For the titration of manganese, if iron is absent, or present only in a small quantity, the solution of the salt of manganese is rinsed into a long-necked boiling flask, with the addition of 1 gramme zinc sulphate, and diluted so that 100 c.c. may contain not more than about ¼ gramme manganese. If the solution is neutral, 2 or 3 drops of pure nitric acid are added (specific gravity 1·2); if acid, it is first neutralized with absolutely pure sodium carbonate, until a permanent precipitate begins to appear, then acidified with 3 or 4 drops of nitric acid, and heated to a boil. The flask is taken from the fire, and the permanganate run in with the burette, promoting the collection of the precipitate by vigorous shaking. The redness which appears toward the end repeatedly disappears again on further agitation. If fine reddish-brown flocculi remain suspended in the liquid, so that it does not become thoroughly clear and transparent, the flask is set for a few minutes on a very gentle fire, but not allowed to boil.

The flocks become more compact and subside on shaking. The liquid at the end of the operation must have a distinct rose color,* which must remain after repeated shaking. The zinc sulphate must be carefully tested; its dilute solution should not, on boiling, destroy the color of a drop of permanganate.

Metallic alloys, such as cast iron and steel, are dissolved for the determination of the manganese in dilute sulphuric acid with the addition of nitric acid. The solution is effected in a liter flask, heated on the water bath. In a mixture of 3 volumes dilute sulphuric acid (1·13 specific gravity) and 1 volume nitric acid (1·4 specific gravity) common bottle wire, on heating in the water bath, dissolves in five or six minutes without violent evolution of gas. The digestion must be prolonged in order to convert the iron completely into oxide. Many ores and slags can only be dissolved by the aid of hydrochloric acid, in which case, after the oxidation of the iron, the hydrochloric solution is mixed with concentrated sulphuric acid and evaporated in a porcelain capsule, first in the water bath and then in the gas stove, till the sulphuric acid begins to escape. The mass is then rinsed with water into the liter flask. The more highly carbureted cast iron, spiegeleisen, and ferromanganese are dissolved in nitric acid in a small flask; the solution, without filtration, is rinsed into a porcelain capsule, evaporated to dryness in the water bath, and heated in the gas stove to the complete decomposition of the nitrates, whereby the carbonaceous matters are burnt. The residual oxides are digested with hydrochloric acid in a covered capsule on the water bath, when the oxides dissolve. The hydrochloric acid is then again expelled by heating with sulphuric acid

The bulk of the acid is next neutralized with pure sodium carbonate or hydroxide. Zinc white suspended in water is then added till all the iron is thrown down, which is ascertained by the circumstance that the solution suddenly coagulates and the supernatant fluid becomes milky. The flask is then filled up to the mark with water, allowed to settle for some minutes, and filtered through a dry folded filter into a dry vessel. A part of the filtrate (200 c.c.) is placed in a boiling flask, acidified with 2 to 4 drops nitric acid, and heated to a boil. The flask is then taken from the fire and the permanganate run in with the burette. The titration can be repeated with a second and a third portion of the liquid.—*Chemical News.*

NEW IRON SALT FOR DEPOSITING STEEL ELECTROLYTICALLY ON COPPER PLATES.

ATTENTION was first called by Boettger to the extreme hardness of iron electrolytically deposited from certain double salts, and the possibility of coating engraved copper plates with it, and thus avoiding the tedious reproduction of them. He has recently recommended the following solution as preferable for this purpose to that of the ammonia of sulphate originally suggested by him, and almost exclusively employed. Dissolve 10 grammes of ferrocyanide of potassium and 20 of Rochelle salt in 200 cubic centimeters of distilled water, and add a solution of 3 grammes of persulphate of iron in 50 cubic centimeters of water; then add to the whole solution of caustic soda, drop by drop, under constant stirring with a glass rod until a perfectly clear light yellowish liquid is produced, which will be fit for immediate use. It may also be employed for dyeing cotton yarn and fabrics a beautiful blue, without a mordant, by immersing them in it, previously slightly warmed, until they are completely saturated with it, allowing them to dry in the air, and finally immersing them in very dilute sulphuric acid (1 to 50), and then washing thoroughly, and drying.

PHYSIOLOGICAL TRANSFORMATION OF SUBSTANCES IN BIRDS.

A SERIES of experiments were conducted by Knieriem to determine whether uric acid, as a final product in the physiological transformation of matter by birds, is preceded by stages similar to those established in regard to the formation of urea in mammals. The experiments were conducted by confining ducks and chickens, and feeding them uniformly until the amount of uric acid excreted became constant, and then feeding them substances the transformation of which into urea in mammals had been demonstrated, and noticing their effect upon the amount of uric acid excreted. The results are briefly summed up as follows: 1. The process of digestion of protein bodies by birds appears to be attended by the formation of the same substances, viz., aspartic acid, leucine, and glycocine, as the digestion of protein bodies by mammals, and they are in this case to be considered as the preliminary stages to uric acid. 2. The same substances, with the exception of ammonia salts, are to be regarded as preliminary to uric acid in the case of mammals that are met with in the formation of urea, at least this is true of the amido acids—aspartic acid, glycocine, and leucine, which were investigated. 3. Ammonia salts, which in mammals are transformed into urea, are excreted by birds unchanged, and in this fact lies the reason for the large amount of ammonia excreted by birds in comparison with mammals.

* The Germans understand, under "rose," a color rather inclining to the violet side of red.

GERMS OF BACTERIA IN THE ATMOSPHERE AND WATER.

A PRELIMINARY statement of some of the results of an exhaustive investigation of the presence of germs of bacteria in water has been made by Pasteur and Joubert. Among them are the following: 1. Germs of bacteria are so abundant in certain waters, as in that of the Seine both above and below Paris, but more particularly below, that a single drop will invariably occasion the development of several species, among them some the germs of which in moist condition and a non-acid medium can withstand a temperature of more than 212°, and, when dry, can even endure heating for several minutes to 266°. These germs are identical with those obtained in 1862 from atmospheric dust. 2. Germs were invariably present in the distilled water of the laboratory, but not as abundantly as in the ordinary water. 3. Distilled water in vessels perfectly freed from germs can be regarded as free from germs of any inferior organisms. 4. Spring water from interior sources is free from germs of bacteria until it comes in contact with atmospheric dust or the surface of the ground. 5. The germs alluded to pass through filters of all kinds, and do not affect the transparency of the water in any way. The authors promise to give a simple method soon for the observation of the germs, and even for counting them and watching their development.

FURNACE SLAG AS A SOURCE OF SULPHATE OF ALUMINA, GELATINOUS SILICA, AND CHLORIDE OF CALCIUM.

ACCORDING to a French patent, finely pulverized slag is treated with hydrochloric acid in peculiar apparatus, uneffected by the latter. The acid solution containing dissolved silica, calcium chloride, and aluminum chloride is drawn off, and diluted with water. The silica is allowed to settle, and the alumina is precipitated from the decanted liquid by pure calcium carbonate, added as an impalpable powder, care being taken not to precipitate the iron also. This precipitate is then rapidly washed and dried, and converted into a sulphate by boiling sulphuric acid. The gelatinous silica is purified by repeated washing with water, and the solution of calcium chloride is evaporated by heat escaping from the drying furnace.

DYEING WOOD BLACK.

THE following processes for imparting a black stain to wood are said to have proved excellent in practice. Make a decoction of about 8 ounces of logwood in from 2 to 2¾ pints of water, dissolve in it from 463 to 540 grains of sulphate of copper, and after settling pour off the clear liquid into a vessel of suitable shape. Immerse the wood for 24 hours in this bath, while it is still hot, or heated anew if necessary. On removal from it, expose it to the air for 12 to 24 hours, and then immerse it in a bath of nitrate of iron (used by dyers), of 4° Baumé. If not of a beautiful black on removal from this, it will only be necessary to replace it in the first logwood bath. Wood may also be dyed a beautiful and permanent black, at ordinary temperatures, and in a single bath, by the so-called patent black, which is also suitable for basket ware. Mix in a copper kettle 4¾ gallons of good wood vinegar, 11 pounds of ground logwood, 8·8 pounds of crushed Aleppo-galls; allow the mixture to stand for a week uncovered, stirring it well frequently every day; then add 10½ pints of water, boil the whole down to 21 pints, and, after settling, pour off the clear liquid.

In the meantime cover 2·2 pounds of clean iron filings in an earthen or stoneware vessel, with 10½ pints of good wood vinegar; stir the mass from time to time until the liquid has a density of 13° to 14° Baumé, allow it to settle, draw it off, and stir it well into the liquid first prepared; allow it to settle, and pour off the clear liquid into the vessel in which it is to be used, and simply immerse the wood in it while cold, and allow it to remain as long as may be found necessary on examining it from time to time. The harder and more compact the wood, of course the longer the time required. The finished wood will take polish very well. The time may be shortened by heating the bath before placing the wood in it; and the addition of 11 to 15 grains of oxalic acid will also hasten the oxidation of the coloring matter of the logwood. The bath can also be prepared more rapidly, and without much additional cost, by employing extract of logwood, and extract of Aleppo galls in the proportion of ⅗ of the crude material required.

The iron liquid may also be prepared by adding freshly prepared solution of green vitriol to a solution of sugar of lead, and pouring off the liquid from the precipitate that forms. Nearly related to the preceding is the exceedingly expensive, so-called Paris ebonywood stain. It may be prepared by heating for a quarter of an hour a mixture of 10 pints of a solution of extract of logwood in hot water of 10° Baumé, with half as much pyrolignite of iron of 11° B., and one-tenth as much acetic acid of 2° B. It is used cold, and for soft woods should be somewhat diluted with water.

Veneerings treated according to the following process, suggested by Puscher, of Nuremberg, are said to be dyed through, and to far surpass in depth of black the best Parisian articles. Boil the crude veneerings for half an hour in an 8 to 10 per cent. solution of caustic soda, and allow them to remain in the lye for 34 hours; then free them from adhering soda by repeated washing, first with hot and finally with lukewarm water, and then immerse them in a hot concentrated decoction of logwood (1 part of fine rasped logwood for three parts of decoction); allow them to remain in it for 24 hours, and, after allowing them to dry off, partially immerse them in a solution, having a temperature of 104° to 113°, of 1 part of green vitriol in 30 parts of water; after remaining in it for 24 hours they will be dyed through and through of a beautiful ebony wood color, and need only be very thoroughly washed, and laid to dry between leaves of pasteboard, subjected to pressure, since they are rendered as flexible as leather by the action of the caustic soda. Oak wood may be made to resemble ebony wood in color perfectly by placing it for 48 hours in a solution of alum, saturated whilst warm, and brushing it repeatedly on removal from this with a decoction of logwood prepared by boiling thoroughly 1 part of the best logwood with 10 parts of water, straining the liquid through linen, evaporating it over a slow fire to half its original volume, and adding to each quart 10 to 15 drops of a saturated solution of perfectly neutral indigo carmine. The wood thus treated is then thoroughly rubbed with a saturated filtered solution of verdigris in strong hot vinegar, the rubbing being repeated until the desired depth of black is imparted. According to Lauth, wood may also be blackened by means of aniline. The wood should first be mordanted in a concentrated solution of a protosalt of manganese, and then be immersed in an alkaline bath and subjected to the action of the air, or in a chloride of lime bath; or it may be treated directly with an alkaline permanganate. It should then be placed in an acid aniline solution, in which it will immediately blacken. A solution of 772 grains of aniline in double the weight of hydrochloric acid and 2 pints of water will answer. The black has a greenish cast, and is rendered darker by washing with a solution of alkali or of soap, and may then be converted into a deep black by washing with a solution of bichromate of potash. This process merits thorough testing by practice.

COLORING OIL VARNISHES WITH ANILINE DYES.

KAYSER has patented a process for coloring oil varnishes with aniline, and thus producing greater permanence of color than with spirit varnishes, without any loss of freshness. Jacobsen also calls attention to the fact that he not only described a process for employing transparent coal-tar dyes for coloring oils and varnishes, as early as 1865, but that since then different preparations for coloring the oils and varnishes, as well as the colored varnishes themselves, have been introduced into the market. Two methods are employed: in one the dyes, which contain colored bases, are converted into compounds of fatty acids with these bases, which are then used for coloring the oils, varnishes, etc.; in the other a common solvent for the coal-tar colors and the oils, etc., is employed, as aniline oil, fusel oil, carbolic acid, etc. Several aniline dyes, as methyl violet, dissolve directly in oil, and others in benzole. He does not recommend any of these varnishes where they may be exposed to a strong light, the oil varnishes being, if anything, more decidedly affected than the spirit varnishes, especially if an excess of free fatty acid is present.

NEW BLUE DYE STUFF.

WILLM & GIRARD prepare a blue dye stuff by heating 200 pounds of diphenylamine and 60 pounds of formic acid, at 248° to 320°, for 10 to 12 hours. After the removal of the excess of formic acid by distillation, 2 pounds of the formodiphenylamine left are heated for 24 hours at 248°, with 4 pounds of oxalic acid in an enameled cast-iron retort, and the mass poured out into benzine; the residue is extracted with boiling water, and dried, then dissolved in alcohol, and the solution warmed with weak potash lye. The resulting reddish blue liquid is filtered and precipitated with concentrated chlorhydric acid, and the blue precipitate is washed with water, and redissolved by treatment with sulphuric acid at 104° to 212°, and the solution used directly in dyeing. Acetic acid may be substituted for the formic acid, and dinaphthylamine for the diphenylamine.

ARTIFICIAL WINE.

ACCORDING to Professor Kletzinsky, the term wine, in a scientific sense, includes any alcoholic liquid produced by the spontaneous fermentation of an unboiled mash, whilst beer results from the fermentation of boiled mash or wort, induced by the addition of some ferment. That in the case of some wines, as Malaga, a portion of the must is boiled, with or without the addition of sirup, and then added to the unboiled portion, does not essentially affect the definition. All liquids then which, besides sugar, contain albuminous matter, and ferment spontaneously without boiling, from whatever source or of whatever proportions of ingredients, produce true wines. Among these are the juices of the birch, the maple, the palm, the agave, and the sugar-cane, and mare's milk, as well as the juice of the grape. And just as the character of a true grape wine is not in the least lost by the addition of young birch twigs to the fermenting must, as along the Rhine, or of quinces, as in some portions of France, so the diminution of the amount of water in the must, or the increase of sugar in it, provided it be made with pure sugar, and without impairing its spontaneous fermentation, does not render the term wine inapplicable to the product. On the other hand, the term artificial wine is only applicable in a strictly scientific sense to such liquids as result from the mixture of the essential ingredients of wine without fermentation, even if the separate ingredients have been prepared from the juice of the grape. As the modes of treatment of the grapes before and after pressing, of the must during fermentation, and of the new wine during storage until fully ripe, are susceptible of improvement, true grape wine may be expected to be the better the more fully the manufacturer is informed upon the progress in this direction. The effort should be to produce a full-bodied wine of fine bouquet, containing at least 10 per cent. of alcohol, 2 per cent. of extractive matter, and at most ½ per cent. of tartaric acid, free from lees and any diseased tendency to souring or to viscous fermentation, the main question involved being as to the quality of the wine, and not whether it required more or less artificial aid in its production.

PARCHMENTIZED COTTON AS A SUBSTITUTE FOR WOOL AND LINEN.

COTTON fiber, it is said, acquires the properties of wool to so great a degree by the following treatment, that it may displace the usual ingredients added in the manufacture of half-woolen goods with improvement in the quality of the fabric. The cleaned raw cotton is simply immersed for 24 hours in a mixture of 1 part of concentrated sulphuric acid, 1 of acid sulphate of glycerine, and 3 of water, at 64°, and is then passed through glass rollers, and washed until perfectly freed from acid. By treatment with a mixture of 2 parts of concentrated sulphuric acid and 3 of water, in the same manner, the cotton not only acquires the properties of linen, but is also rendered stronger and less liable to rot than the latter, whilst its price is much less.

SOLVENT FOR SALICYLIC ACID.—The difficult solubility of salicylic acid prevents its ready use in medicine. Kohlmann recommends acetate of ammonia as a solvent for it, and the following as the simplest plan for preparing a 20 per cent. solution for medicinal purposes. Cover 10 parts of salicylic acid with 24 parts of ammonia, shake frequently until it is dissolved, and then add 16 parts of dilute acetic acid, or just enough to produce a slightly acid reaction. The solution has a saline taste, which, however, is not at all disagreeable.

DR. ASA GRAY.

An account of some of the persons who have contributed largely to increase our knowledge of materia medica would be incomplete without some mention of Dr. Asa Gray, the Fisher Professor of Natural History in Harvard University, whose portrait accompanies this notice.

Professor Gray was born on the 18th of November, 1810, at Paris, Oneida County, N. Y., and in 1831 received the degree of M.D. from the medical school at Fairfield, N. Y. He continued but a short time in the practice of medicine, preferring to devote himself exclusively to the study of botany. In 1834, Dr. Gray was appointed botanist to the U. S. Exploring Expedition, but resigned the position three years later, owing to the delay of the enterprise, and was subsequently elected Professor of Botany in the University of Michigan. Before this institution had completed its organization, he accepted the Fisher Professorship of Natural History in Harvard University, in which position he has continued since 1842.

In 1834-35, Dr. Gray published two volumes of the "North American Gramineæ and Cyperaceæ"—one of his earliest contributions to botanical literature. Each volume contained a hundred species, illustrated with dried specimens. The work was sold by subscription, and the number of copies published was necessarily limited. In it were described several new species, and the characters and synonyms of many of those already known were revised. The work, although now very rare, is still an authority upon the subjects to which it relates.

In December, 1834, Dr. Gray read before the New York Lyceum of Natural History a paper entitled "A Notice of some New, Rare, or Otherwise Interesting Plants from Northern and Western Portions of the State of New York," which at once gained for him much credit among scientific men. In 1838 appeared the first part of the "Flora of North America," which he edited conjointly with Dr. John Torrey, of New York. The work was, however, not completed, for by the time it had reached the end of "Compositæ" its authors were so overwhelmed with materials which rapidly accumulated, that their time was occupied in studying and classifying the specimens, and it was then evident that so many additions would be needed to the portion already gone over that an appendix would embrace more space than the original text itself. Instead, therefore, of continuing the "Flora of North America," its authors published from time to time, conjointly and separately, a series of memoirs, among which the following, by Professor Gray, are noticeable: "Plantæ Lindheimeranæ"—giving a description of the plants collected by F. Lindheimer in Western Texas; in which work Dr. Gray was aided by Dr. Geo. Engelmann; "Plantæ Fendlerianæ"—a description of plants collected by Aug. Fendler, in New Mexico; "Plantæ Wrightianæ Texano-Neo-Mexicanæ"—describing the extensive collection of Charles Wright, A. M.; "Plantæ Thurberianæ," etc. During the past year, however, the materials which had been collected and elaborated for so many years had approached such a state of completeness, that the author felt warranted to proceed with the work. Accordingly he published the first volume of a "Synoptical Flora of the U. S.," which begins where the former work left off, and which, when completed, will be followed by a revised edition of the preceding portion.

In 1848 appeared the first volume of "Genera Floræ Americæ Boreali-Orientalis Illustrata," more commonly known as "Gray's Genera." The object of this work was to give one or more species of each genus of North American plants, with accurate analyses. Only two volumes, however, were issued, owing to reasons similar to those which arrested the publication of the "Flora."

Dr. Gray is the author of two volumes containing descriptions of all the plants collected during the years 1838 to 1842 by the Expedition of Commodore Charles Wilkes, excepting the specimens gathered on our Pacific coast. This is the most voluminous and, in many respects, his most important contribution to botanical literature.

As early as 1836 appeared the "Elements of Botany," which grew into the "Structural and Systematic Botany," and later became the "Botanical Text-Book" of the present day. This is acknowledged to be one of the best and most practical exponents of vegetable physiology in existence, and has rendered other works on this subject in this country almost superfluous. Another of his important works is the "Manual of the Botany of the Northern United States," which first appeared in 1848 and has already gone through several editions.

Not less valuable, in a broad sense, are writings adapted to popular use and even to the comprehension of children. In works of this class Professor Gray may almost be said to have been the pioneer, and his "First Lessons," "How Plants Grow," and "How Plants Behave," are widely known and well appreciated.

Numerous contributions have been made by him to the columns of the *American Journal of Science and Arts*, of which he has long been one of the editors; while others, on subjects not always connected with botany, have appeared in the *North American Review* and other magazines.

For many years Professor Gray held the office of President of the American Academy of Science and Arts, and in 1872 he was President of the American Association for the Advancement of Science.

After the foregoing account of important achievements, it is hardly needful to remark the persistent industry of their author. Being possessed of robust health and systematic habits of labor, much has been accomplished by him that would have been left undone by one less fortunate than he in these respects; nevertheless the works of Professor Gray are something more than industrious compilations, and evince a genius for the study of science that is rarely met with, and which, when employed as it has been in the present instance, not only renders its possessor respected of all men, but reflects honor upon the country which affords a field for his labor.*—*New Remedies.*

PROFESSOR ASA GRAY, OF CAMBRIDGE, MASS.

THE BUD LOUSE.

In his paper before the American Association on "bud-blight" insects, Dr. W. S. Barnard, of Cornell University, said that his attention had been called to the subject last June, by the pear trees in the neighborhood of Ithaca. The ends of the twigs were enlarged and the buds fell off. In Saratoga he had seen the same ruin worked. In all pear-blights there appears a fungus arising from some injury, as excessive freezing or beetle boring. If the leaves alone blight with brown or black blotches, the cause is the presence of mites burrowing in the pulp. The death of buds alone cannot be ascribed to any of these adverse influences. The absence of fresh surfaces in the present case showed that the evil was not the work of cut-worms or caterpillars. He found it due to a very inconspicuous insect well known in Europe as an old offender, under the name of the pear-psylla (*Psylla pyri*). As this insect had never been described or figured in this country, Dr. Barnard supplied the deficiency and showed drawings. He also described the various methods of discovering their presence.

The writer thought "bud louse" an appropriate name, since it is closely allied to the common plant lice (*Aphidæ*). It is diminutive and has a gradual and complete metamorphosis. It is provided with wings for flight, and has legs so strong that it can leap like a flea. It lays its pollen-like, almost invisible eggs on the petioles or along the veins of the leaves (where the adults also are commonly seen), each anchored to its place by a filament. During the early life of the louse there exudes from the body a waxy secretion which forms a fibrous mesh on the plant probably to protect the young against the beating winter storms. To manufacture this secretion and the "honey-dew" which they squirt upon the leaf, as well as to nourish themselves, an immense quantity of the sap of the tree is consumed. The ants attend and milk these lice affectionately, as they do the aphides.

Honey-dew is yielded by both young and old. In Europe this louse, in all its stages, attacks the leaves, blossoms, and young shoots, gradually killing the tree. The main injury here is done by the larvæ, which destroy the buds by sucking the sap about their bases. Dr. Barnard thought the damage which this insect was doing to the pear orchards was very large and liable to be spread widely. It appears to have been imported into the United States 46 years ago, has done great harm, and is being widely disseminated, through nursery sales. It therefore deserves close attention and Dr. Barnard would be glad of additional observations to aid him in devising some means of successful warfare against it.

* The basis for the above sketch was found in the *Popular Science Monthly* for August, 1872. The portrait is from a recent photograph.

THE KANSAS GAS AND COAL WELLS.

By J. THORNE, M.D.

OVER a year since the Kansas Rolling Mill Company began drilling for gas at Rosedale (4 miles S. W. of Kansas City). The work, having been abandoned by the company, was continued by private enterprise until four wells have been sunk with the results tabulated below.

The wells are all near the town of Rosedale, within the radius of a mile of each other; all are in the valley of Turkey Creek. No. 1 is at the mill, No. 2 is over ¼ a mile nearer Kansas City, No. 3 is ¼ of a mile above the mill (S. W.), and No. 4 ¼ of a mile north of the mill.

	Well No. 1.		Well No. 2.		Well No. 3.		Well No. 4.	
	FT.		FT.	IN.	FT.	IN.	FT.	IN.
Surface dirt (loam, gravel, and clay)	23		14	0	18	0	13	0
Limestone	40		5	0	21	0	20	0
Soapstone	180		2	0	0	0	0	0
Black shale	0		0	0	2	0	2	0
Limestone	8		10	0	15	0	5	0
Soapstone	0		118	0	75	0	8	0
Limestone	0		3	6	2	0	10	0
Soapstone	0		59	0	60	0	127	0
Limestone	0		5	0	5	0	5	0
Coal	3		0	0	0	0	0	0
Black shale (gas)	0		2	6	0	0	0	0
Soap and limestone	0		15	0	0	0	15	0
Green shale	20		0	0	0	0	0	0
Soapstone	0		40	0	35	0	8	0
Black slate	6		0	0	0	0	0	0
Sand shale	0		1	6	0	0	0	0
Soapstone	20		9	0	0	0	0	0
Black slate	8		0	0	0	0	0	0
Limestone	0		2	6	5	0	4	0
Soapstone	0		19	0	10	0	7	0
Green shale	20		0	0	0	0	0	0
Limestone	1		2	4	0	0	10	0
Soapstone	0		4	0	0	0	0	0
Black slate (gas 50 lb.)	0		1	8	0	0	2	0
Coal	5		0	10	0	4	0	0
Soapstone	11		0	0	2	0	0	0
Fire clay	0		1	6	0	0	0	0
Limestone	0		4	5	0	0	3	0
Sand shale (large stream of salt water)	0		0	0	11	0	0	0
Black slate	0		0	0	9	0	8	0
Limestone	0		0	0	0	0	7	0
Soapstone	0		0	0	6	0	0	0
Black shale (80 lb. gas)	0		0	0	15	0	10	0
Soapstone	0		0	0	10	0	5	0
Limestone	0		0	0	1	0	5	0
Soapstone	0		0	0	82	0	0	0
Black slate	0		0	0	0	0	5	0
Limestone	0		0	0	0	0	10	0
Black shale	0		0	0	0	0	5	0
Limestone	0		0	0	18	0	2	0
Black slate	0		0	0	0	0	4	0
Soapstone	0		0	0	4	0	6	0
Limestone	0		0	0	2	0	3	0
Slate (strongest gas)	0		0	0	4	0	2	0
Limestone	0		0	0	0	0	3	0
Gray shale	0		0	0	0	0	3	0
Black slate	0		0	0	0	0	2	6
Coal	0		0	0	0	0	2	0
Soapstone	0		0	0	2	0	0	0
Sand shale	0		0	0	16	0	10	0
Total depth of each well	345	320	9	430	4	330	6	

The surface at Nos. 1 and 3 is about 50 feet above the Kansas City Water Works; No. 2 is about 20 feet less, while No. 4 is about 10 feet higher than No. 2.

The first thing which will be noticed in the above table is the great diversity in the earth's crust, and this diversity constitutes the chief interest of the record. Thus the first limestone in No. 1 is 40 feet, while in No. 2, about ½ a mile N. E., it is only 5 feet; at No. 3, ¼ of a mile in the opposite direction, it is 21 feet, and at No. 4, between Nos. 1 and 2, it is 20 feet. Under the limestone comes soapstone. In No. 1 it is 180 feet, in No. 2 only 2 feet, while none is found in either three or four for some time. To a geologist the table will be full of such anomalies.

It is the object of this paper to present the facts only, leaving their analysis to others. The gas features of the wells are important in the relation they will sustain to economic questions. In No. 1 we find gas which burns strong from a 1 inch pipe at 274 feet, while 50 feet lower we have a pressure which could not be measured by the instruments at hand. In No. 2 we find it at 216 feet, and 92 feet lower we find it of 50 pounds pressure (this pressure became much greater after a few days). In No. 3 we have a volcano. The flame, from a 3 inch pipe, is thrown over 20 feet horizontally, while from a 5 inch pipe it roars in a mass of flame 20 feet or more in the air. No. 4 is much the same as No. 3. The escape of gas is continuous, and seems to increase after two months' time. It will be noticed that the gas always comes from the slate or shale formations.

The readers of the *Review* may be interested in knowing how specimens are obtained from so deep a hole. The old method was by small particles brought up by the sand pump, but Mr. Charles Swan, the man in charge of the drilling, invented, for this occasion, a method whereby large pieces could be brought to the surface. First, a 3 inch hole is put down with a sharp drill, then a blunt instrument 5 inches in diameter, called a reamer, is put to work, carrying before it (in the 3 inch hole) a long cylinder or bucket, the rock as detached falls into the bucket, and when drawn up shows the exact strata. This invention is of great value in determining the character of the earth's crust.—*Kansas City Rev.*